

NAVAL POSTGRADUATE SCHOOL

Monterey, California



DISSERTATION

**LOW ALTITUDE
OPTICAL SIGNAL PROPAGATION
OVER THE OCEAN
(VOL. II)**

by

Lean-Weng Yeoh

March, 1997

Dissertation Supervisor:

Hung-Mou Lee

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13. ABSTRACT (maximum 200 words) The effects of ocean surface waves on optical signal fluctuations and optical refraction are evaluated. The effects on signal fluctuations were inferred from the ocean surface wave spectral density and temperature fluctuation spectral density. The effects of ocean waves on optical refraction are manifested in the near-surface gradient of the temperature profile. A modified temperature profile incorporating a statistical mixing length scale is proposed. The research points to the importance of certain parameters that should be considered when optical signals skim the ocean surface.				
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**LOW ALTITUDE
OPTICAL SIGNAL PROPAGATATION
OVER THE OCEAN**

Lean-Weng Yeoh
Ministry of Defence, Singapore
M.S., Naval Postgraduate School, 1990
E.E., Naval Postgraduate School, 1990

Submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN ELECTRICAL ENGINEERING

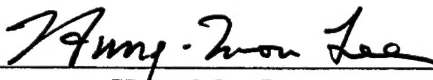
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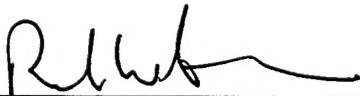
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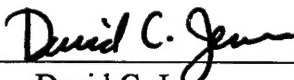
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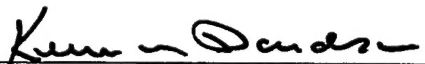

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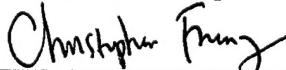
Approved by:


Hung-Mou Lee
Associate Professor of Electrical and Computer Engineering,
Dissertation Supervisor

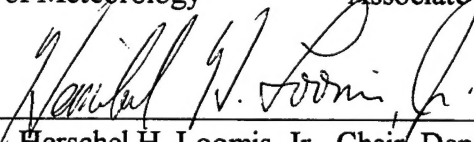

Richard W. Adler
Senior Lecturer of
Electrical and Computer Engineering


David C. Jenn
Associate Professor of
Electrical and Computer Engineering

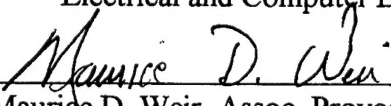

Kenneth L. Davidson
Professor of Meteorology


Christopher Frenzen
Associate Professor of Mathematics

Approved by:


Herschel H. Loomis, Jr., Chair, Department of
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PREFACE

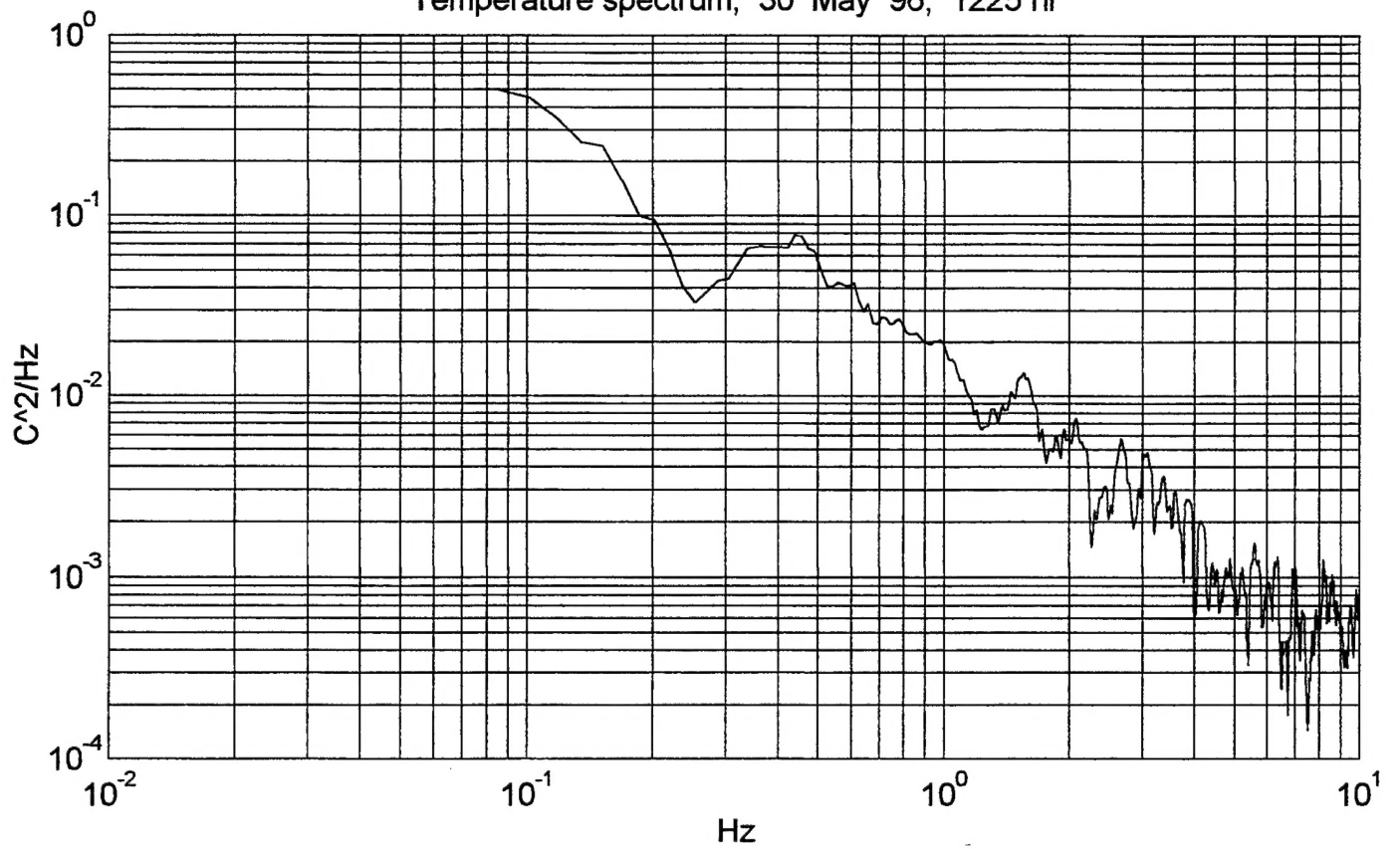
This volume contains the complete set of plots of signal samples and the corresponding temperature and ocean surface wave spectra. Ray tracing plots for optical signal samples not occluded by ocean surface waves are also included.

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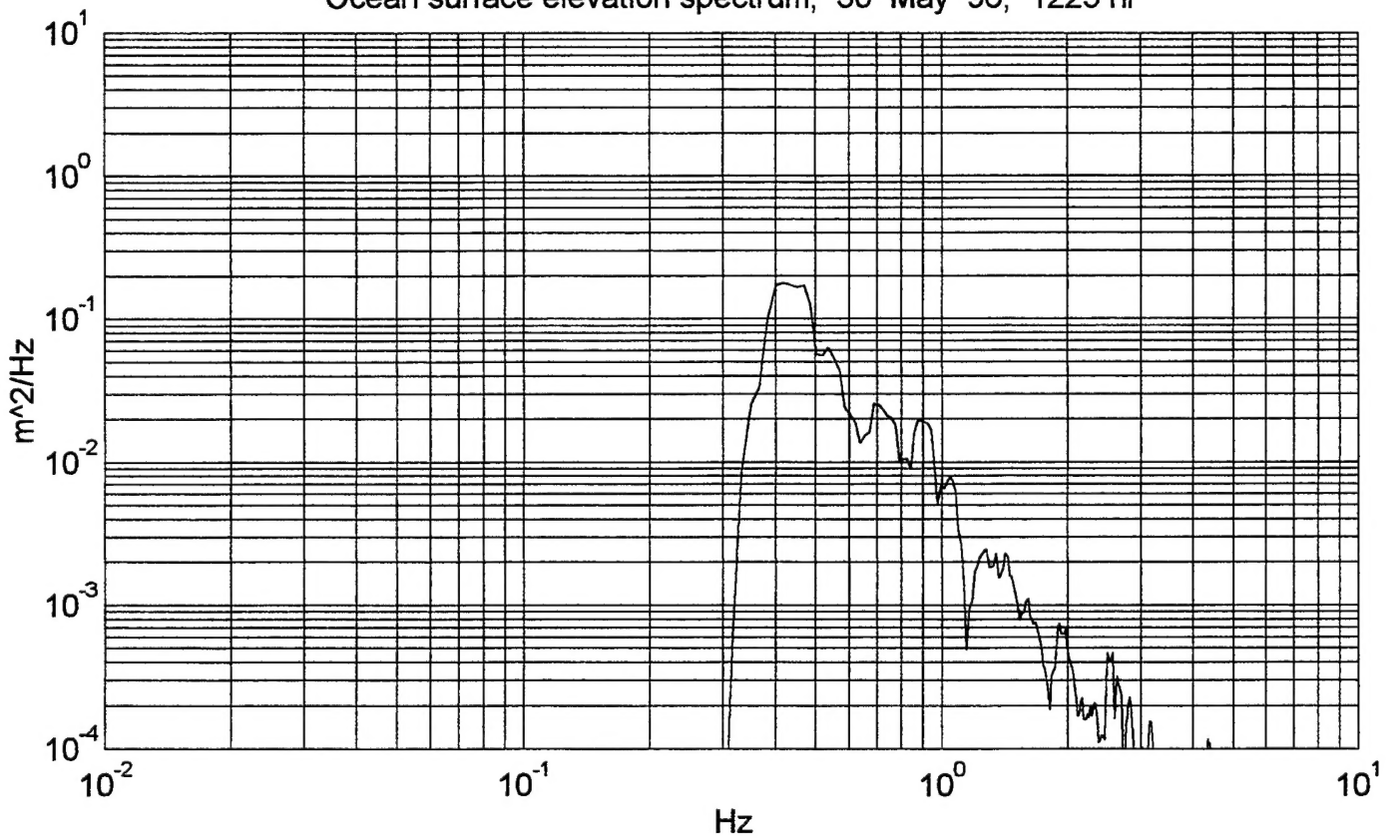
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I. TEMPERATURE SPECTRUM AND THE CORRESPONDING WIND WAVE SPECTRUM

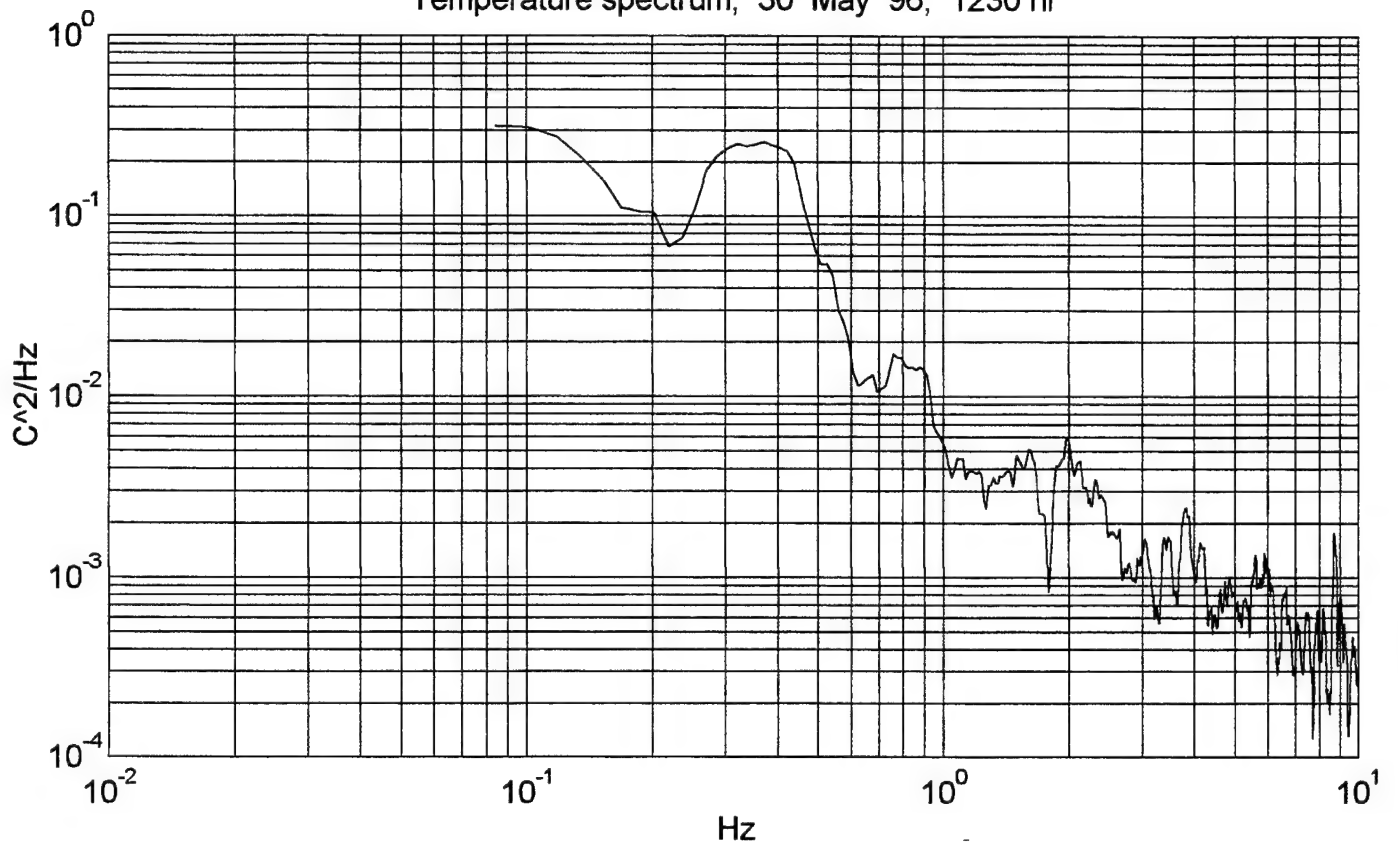
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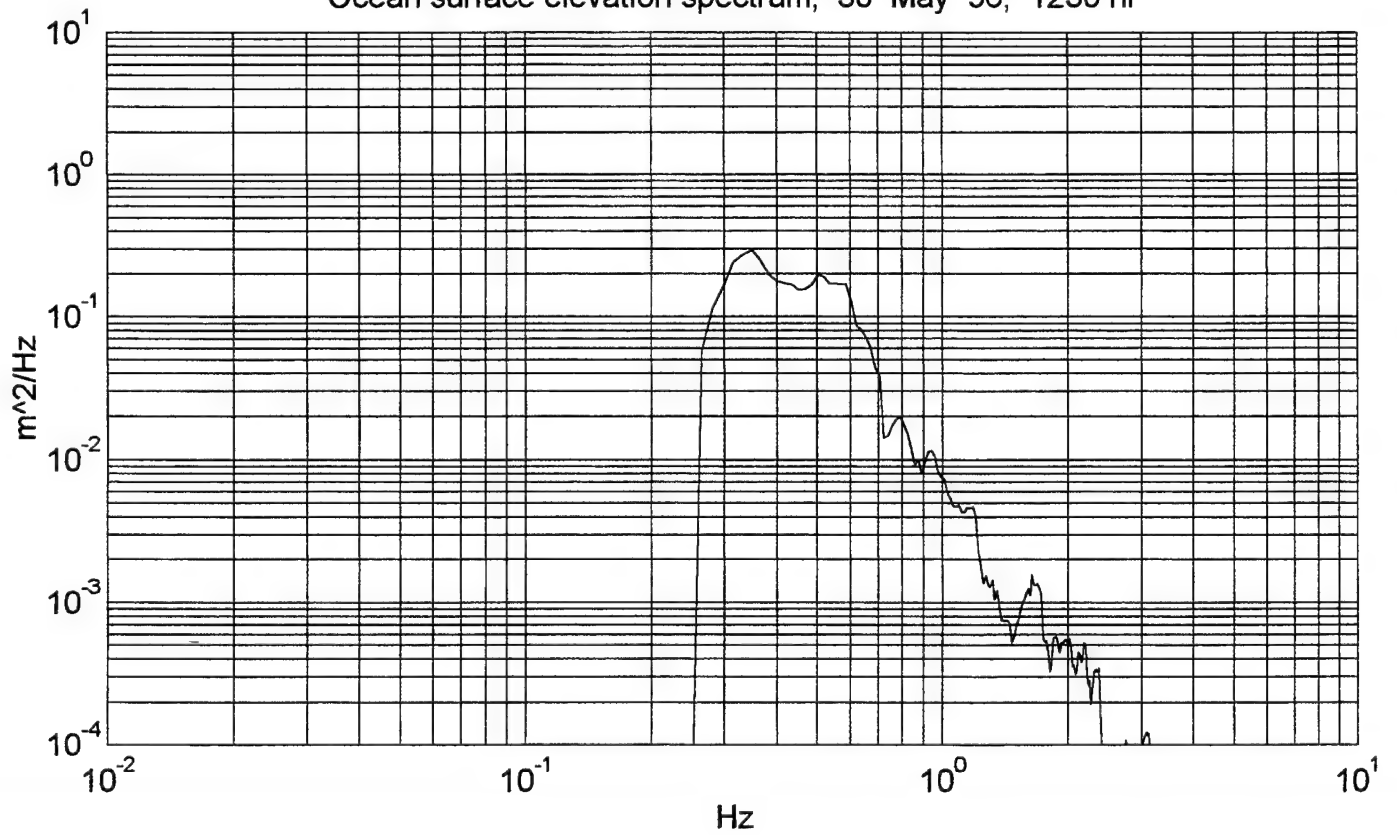
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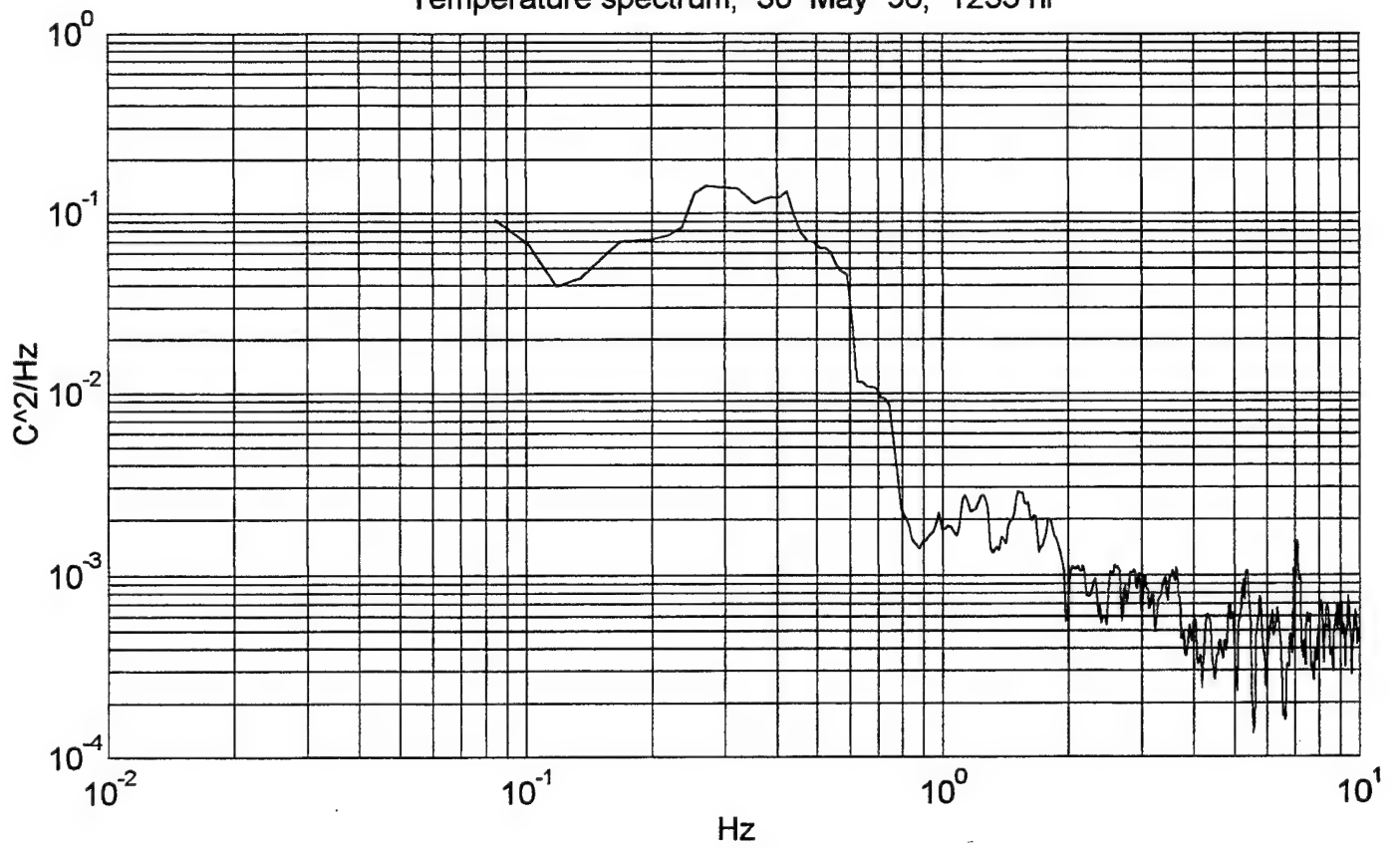
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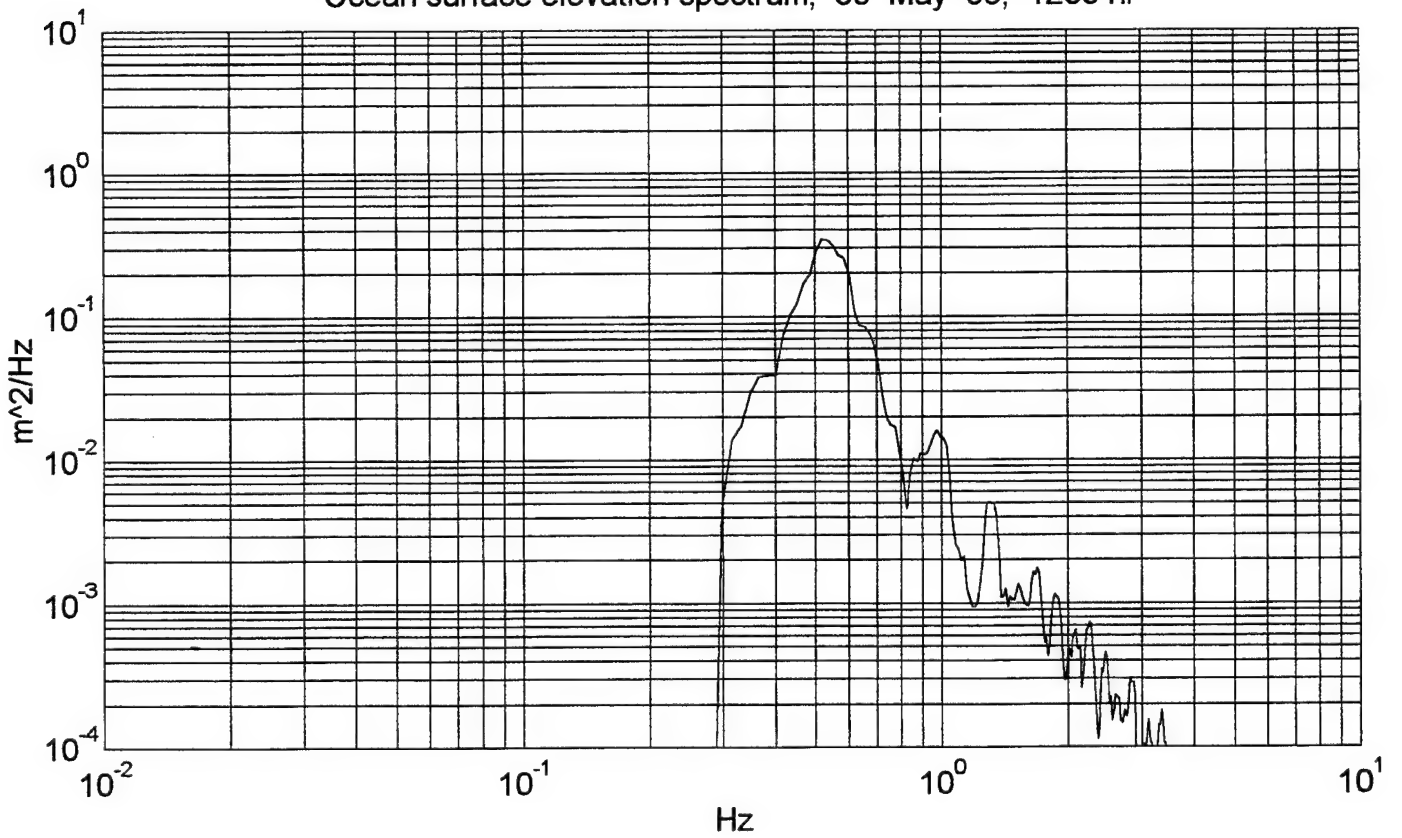
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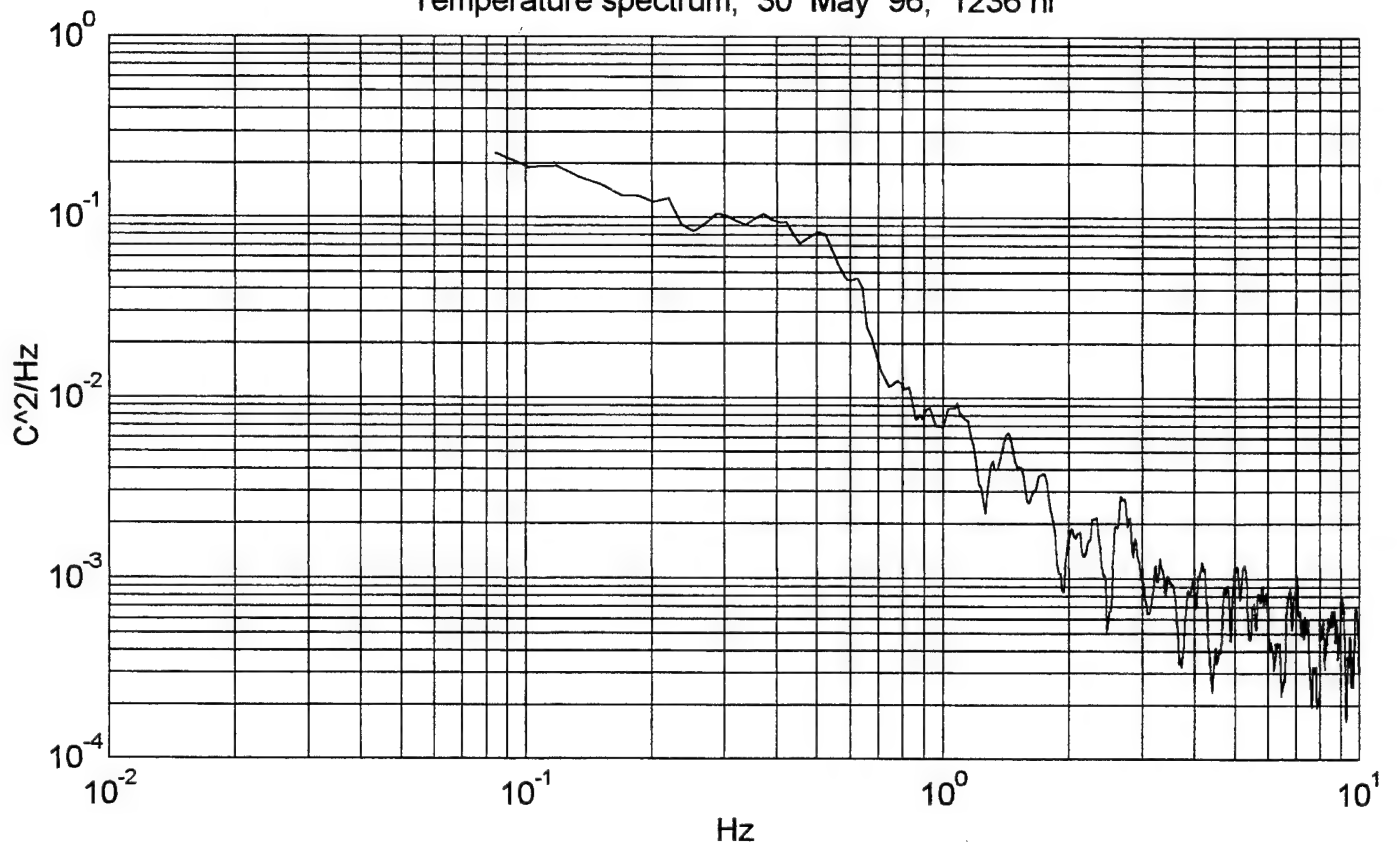
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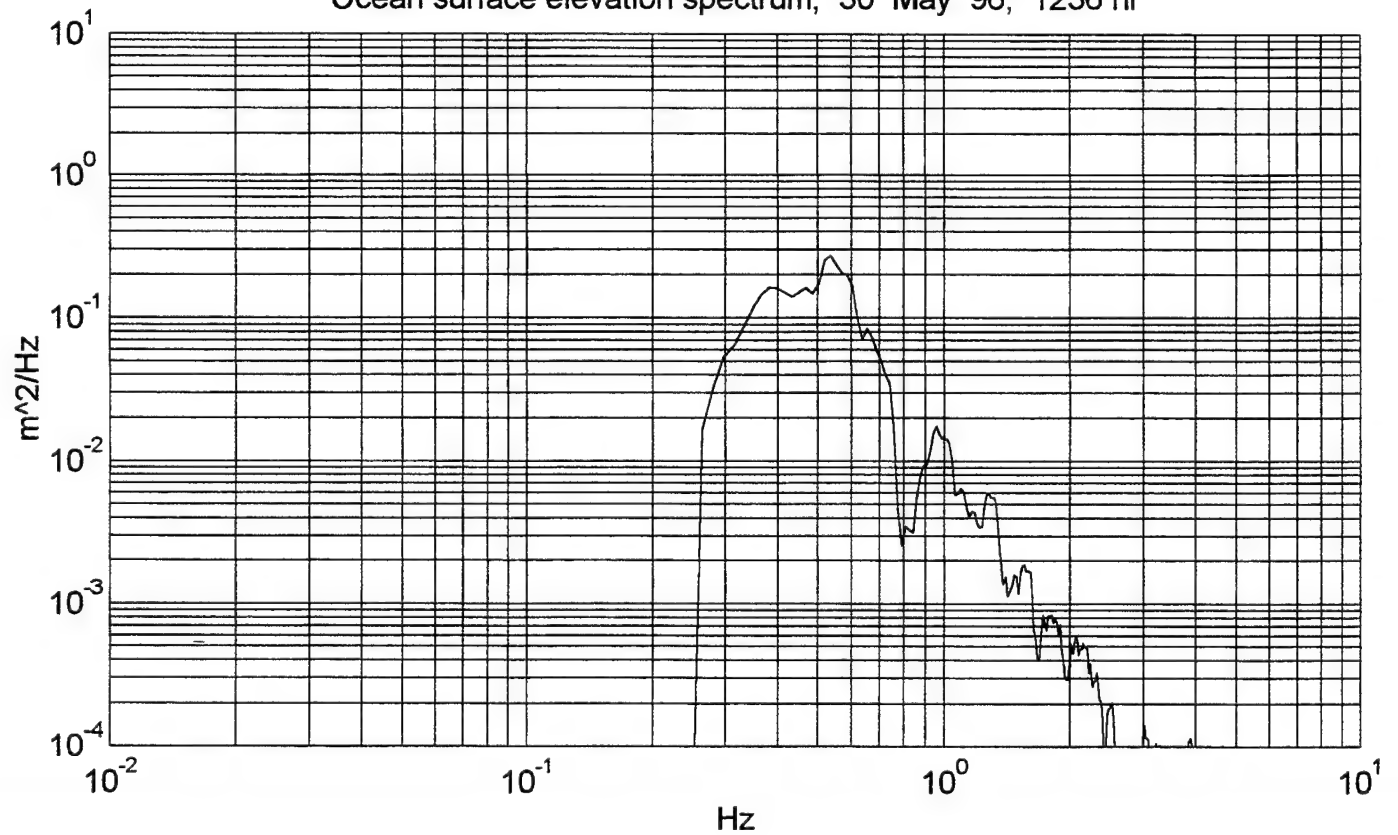
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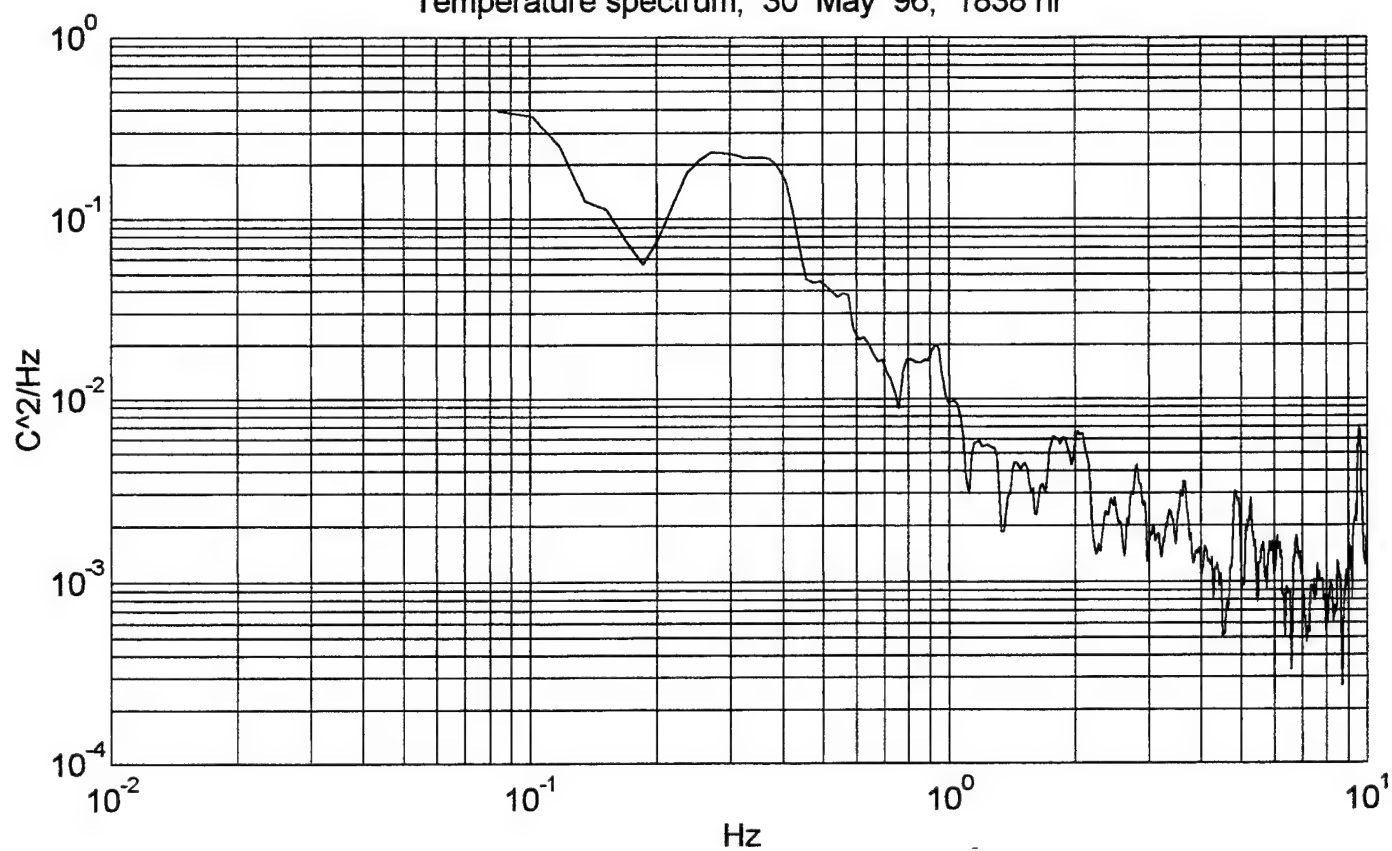
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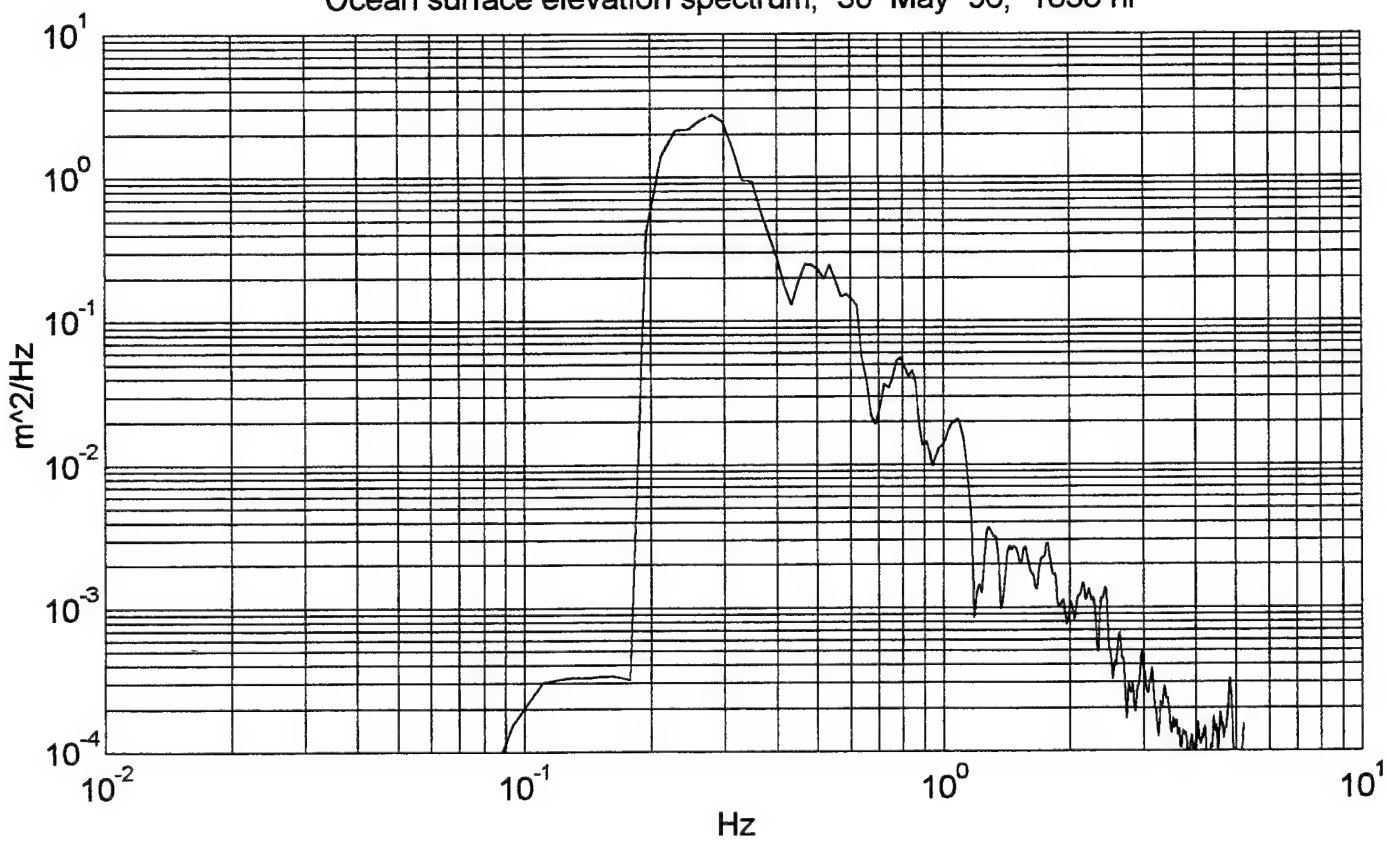
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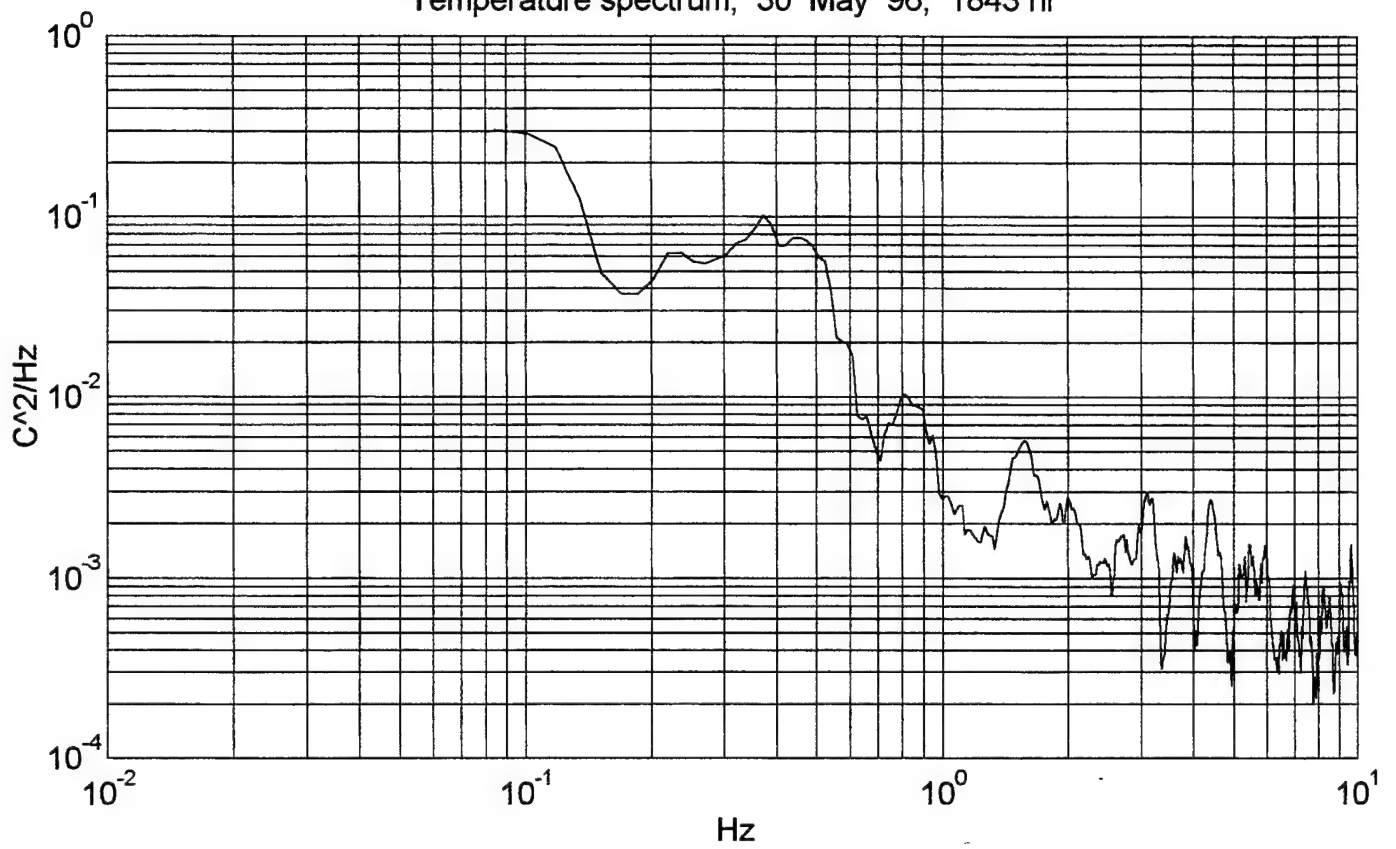
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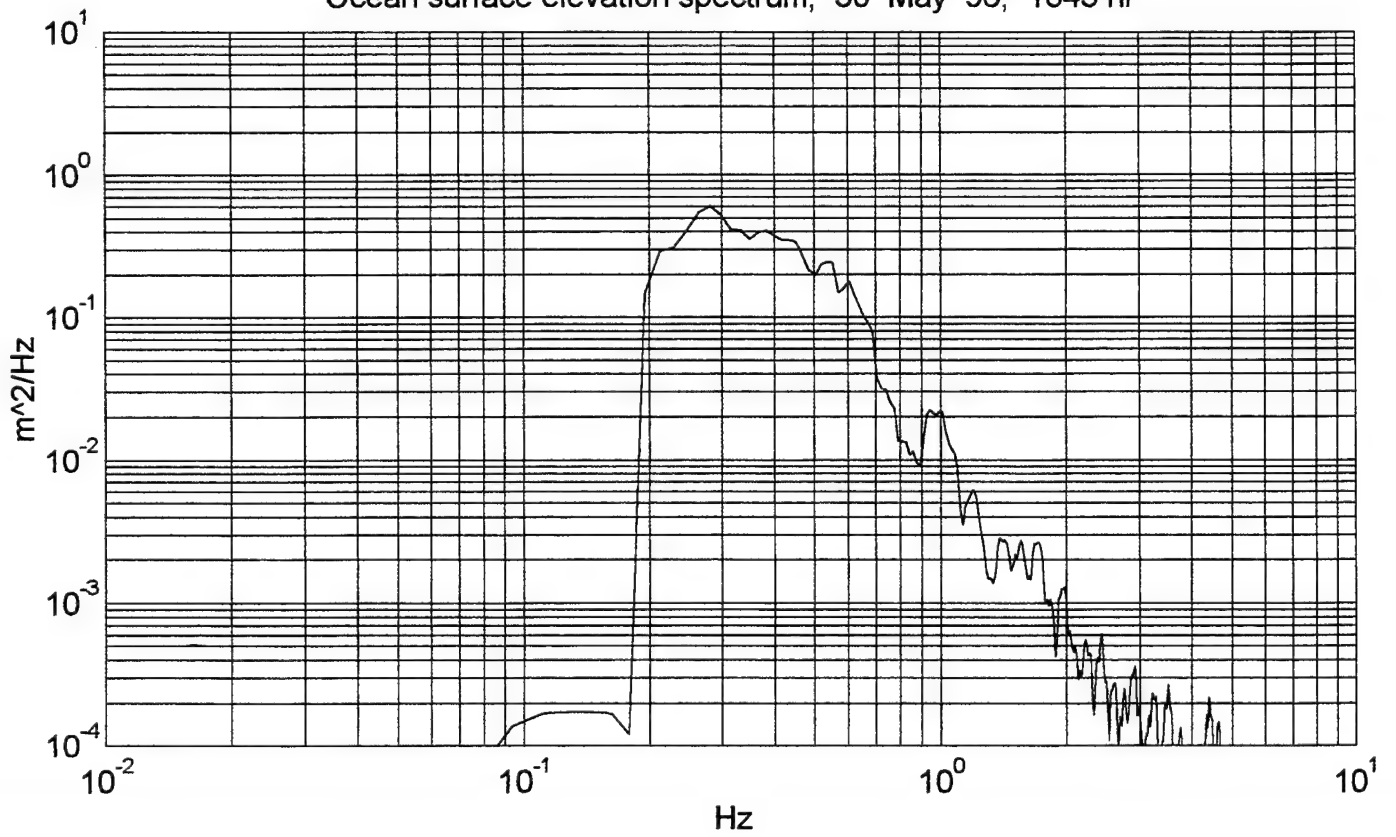
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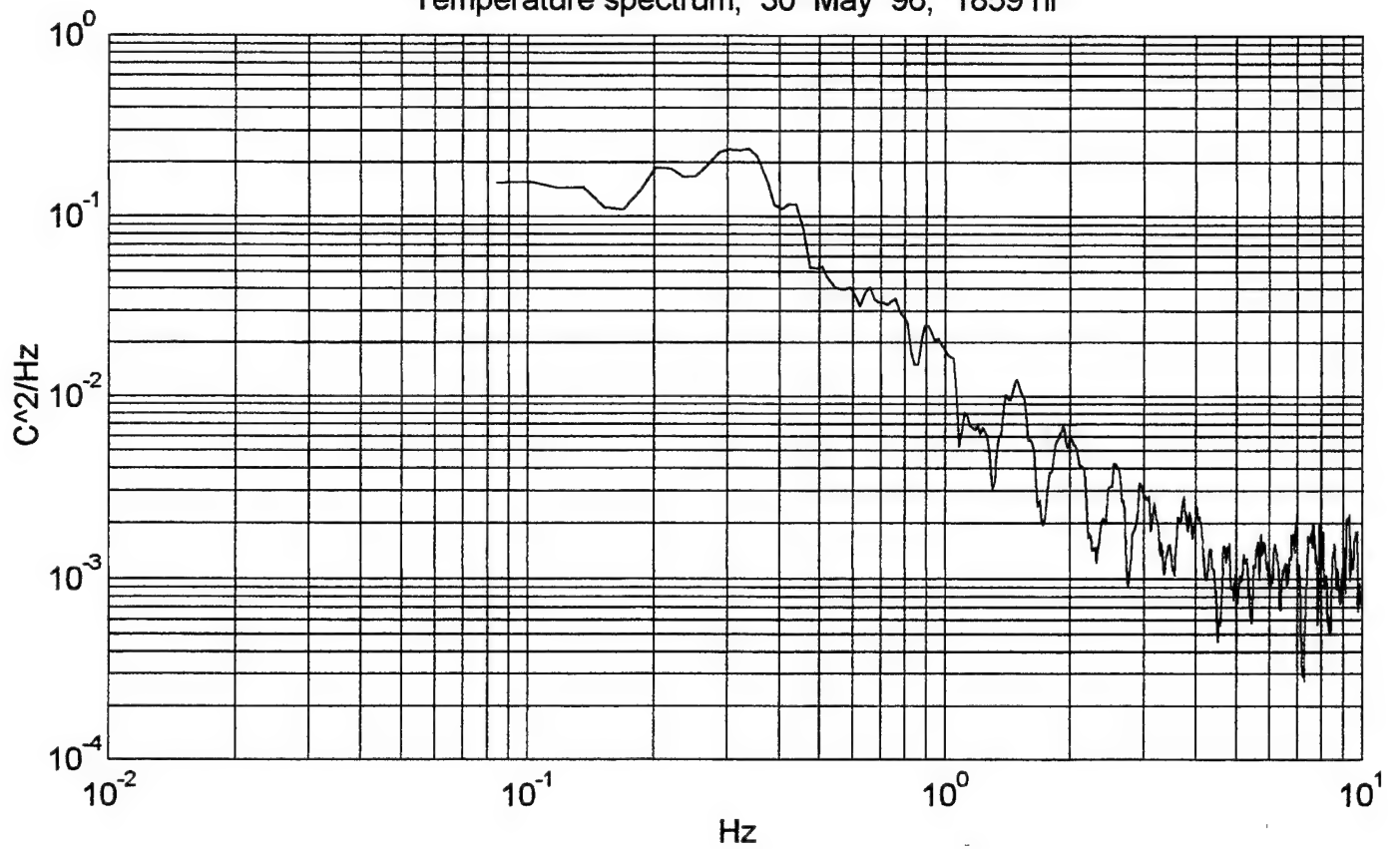
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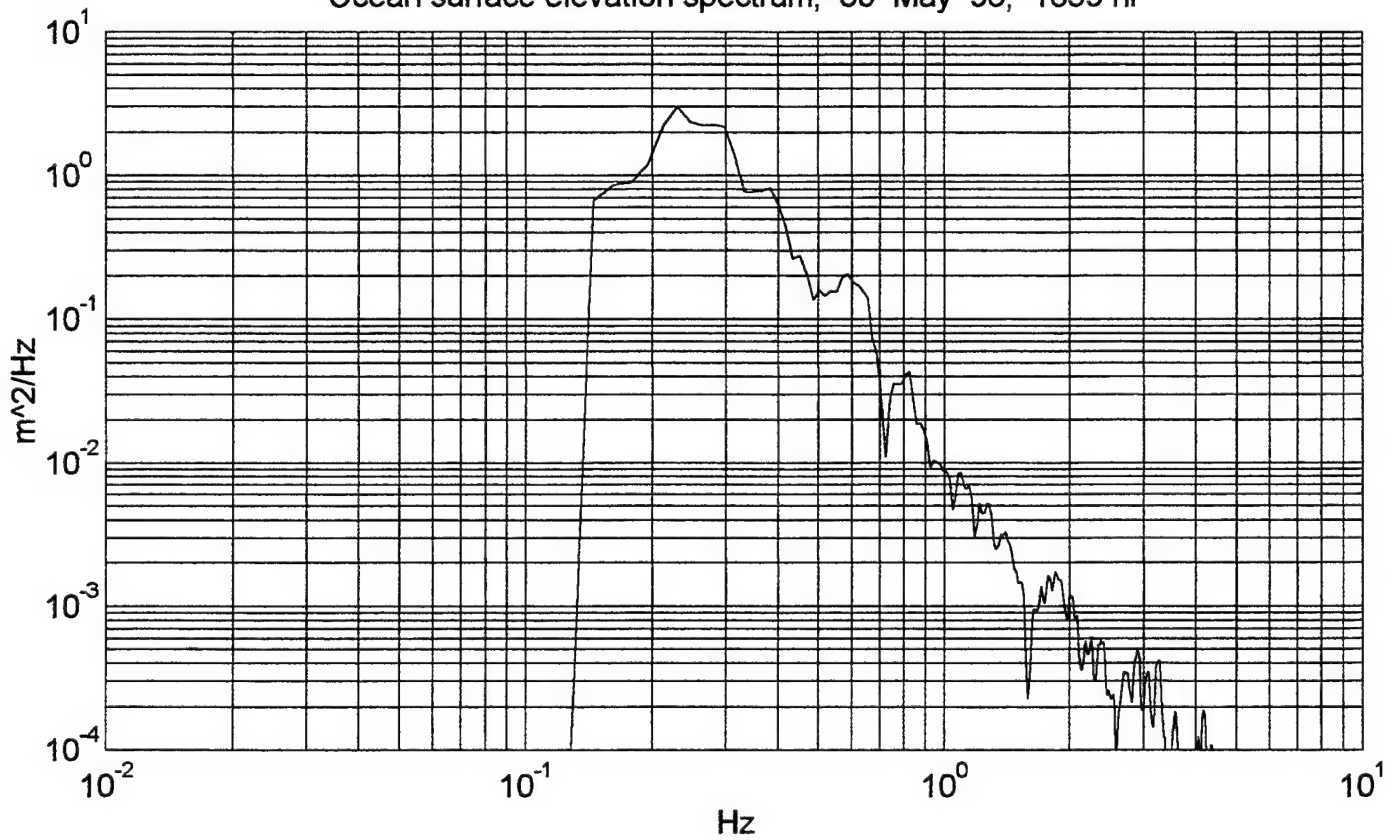
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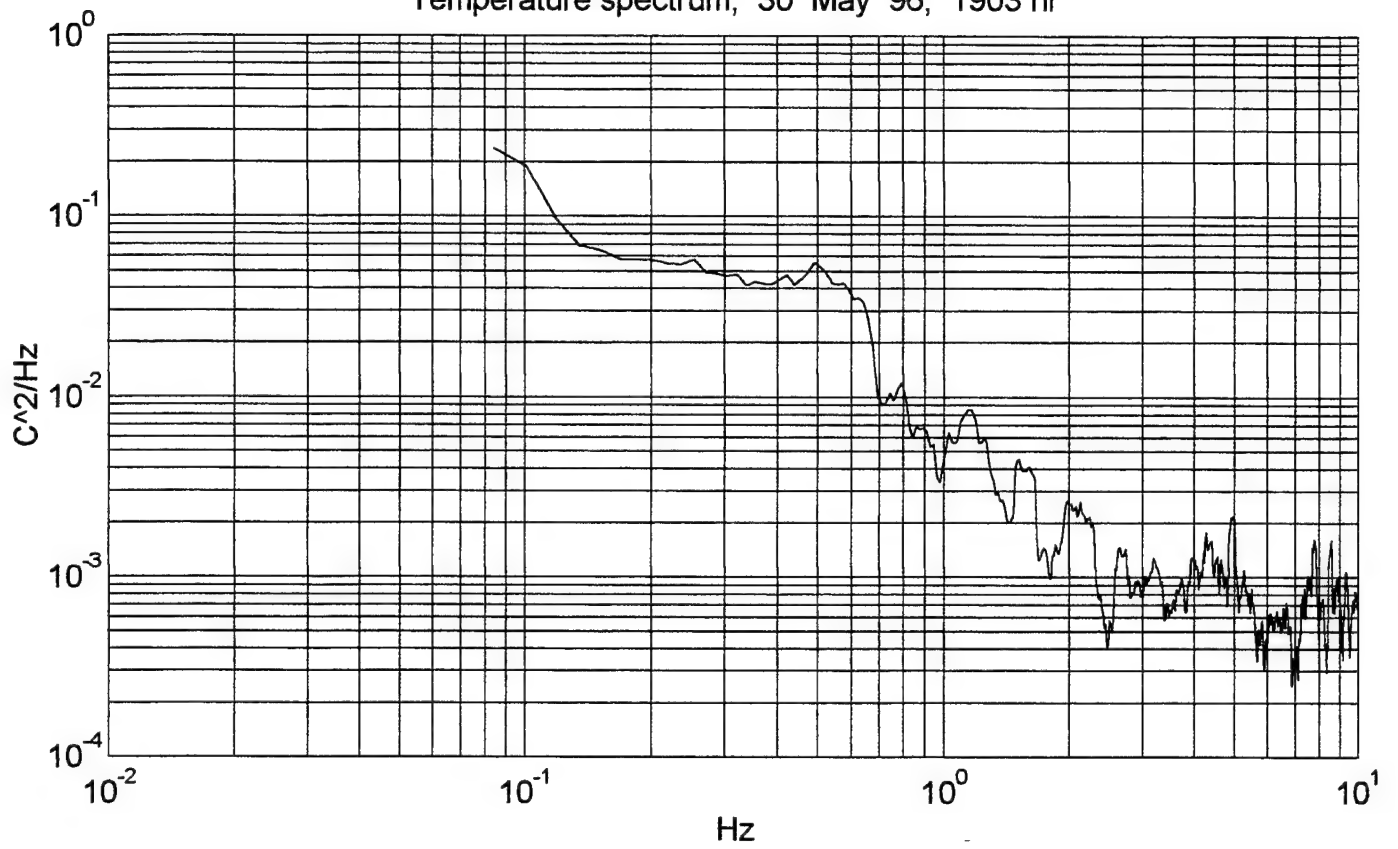
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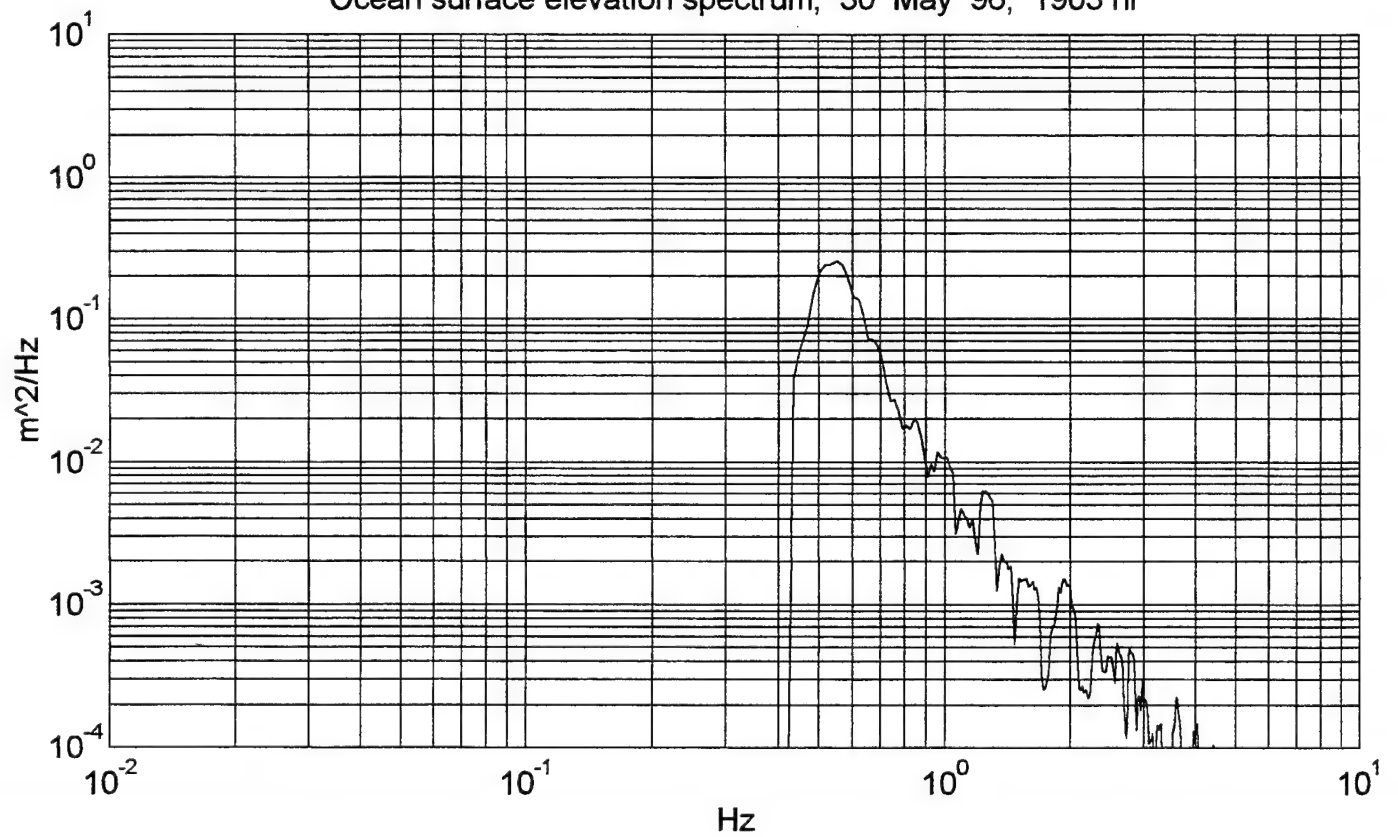
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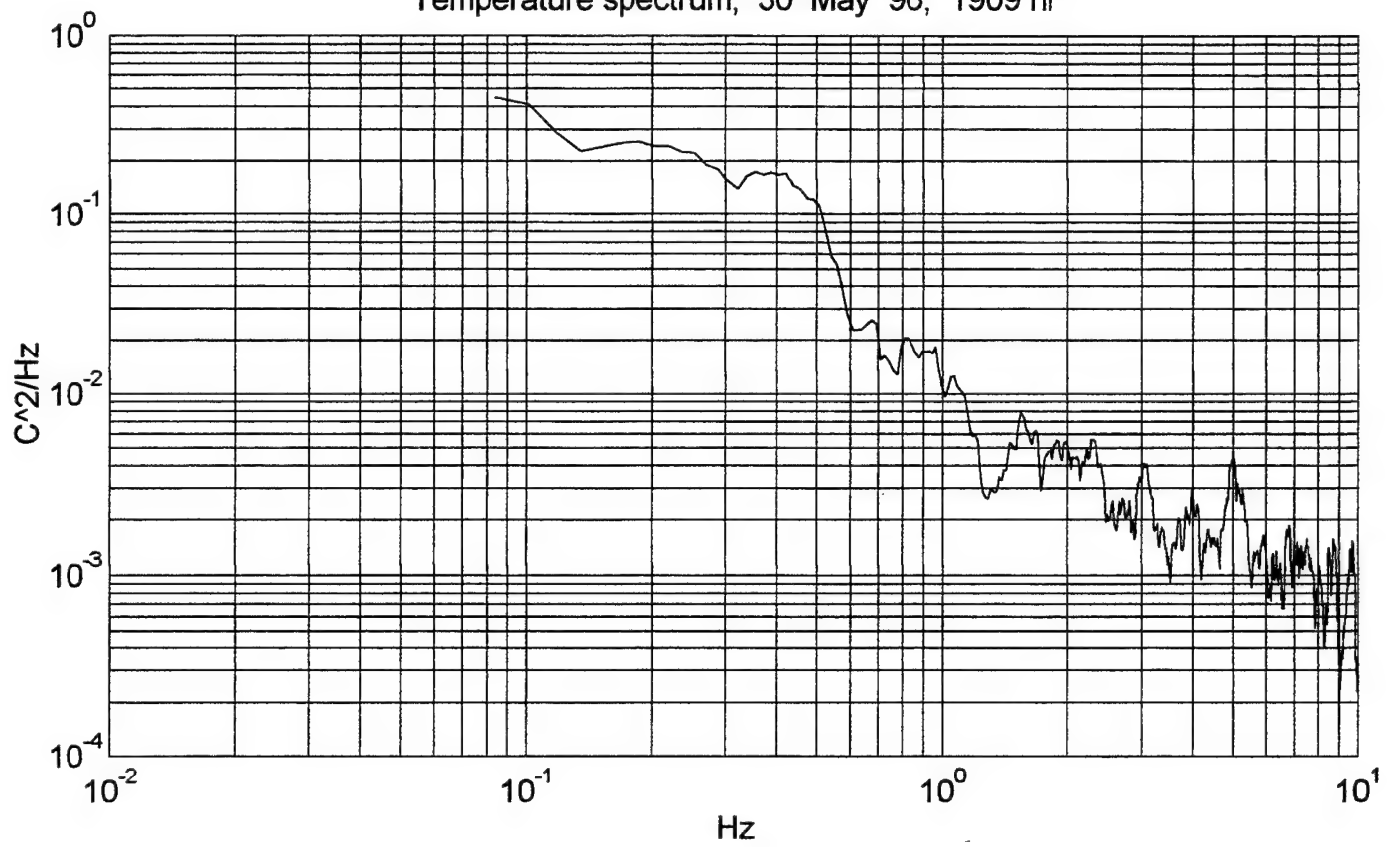
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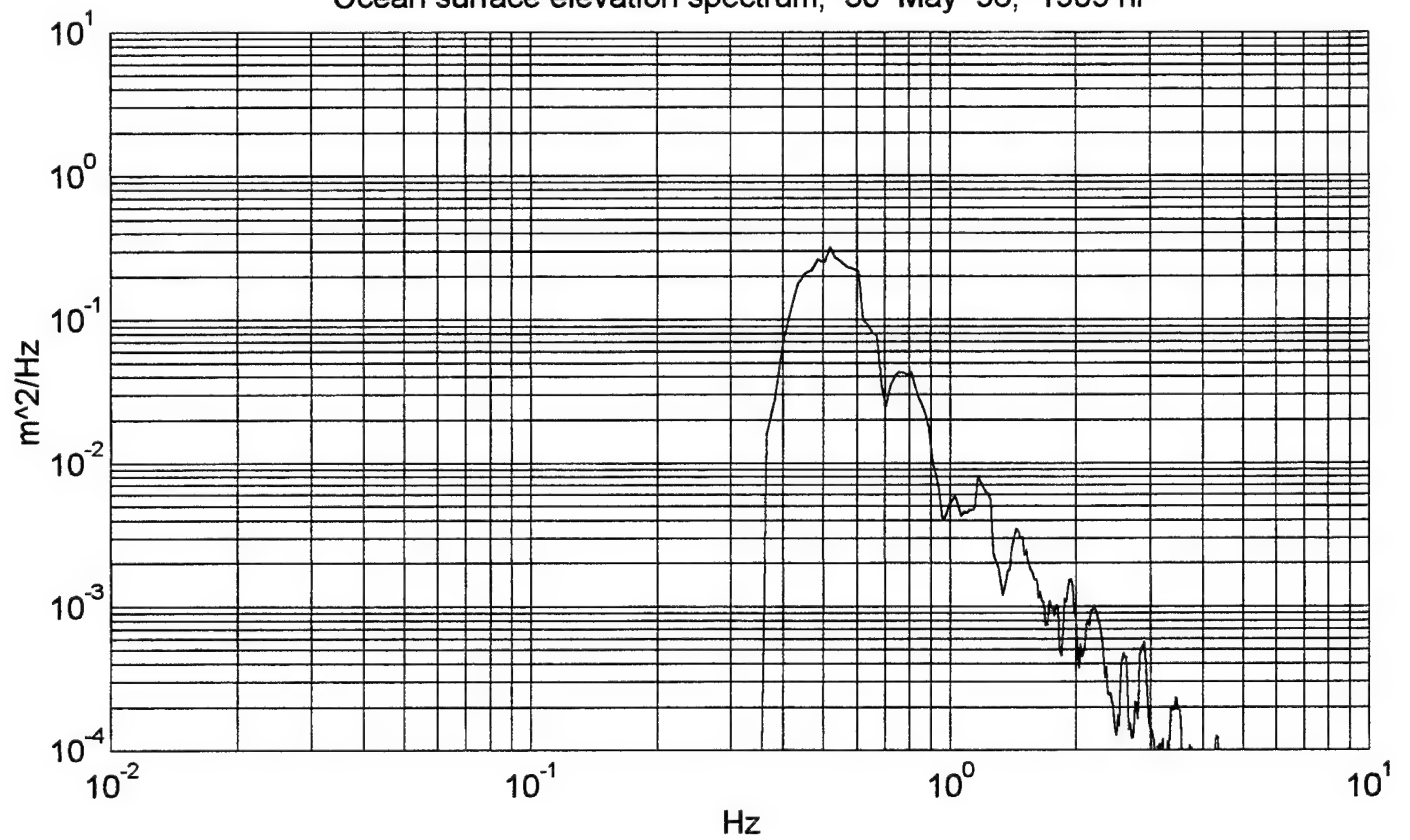
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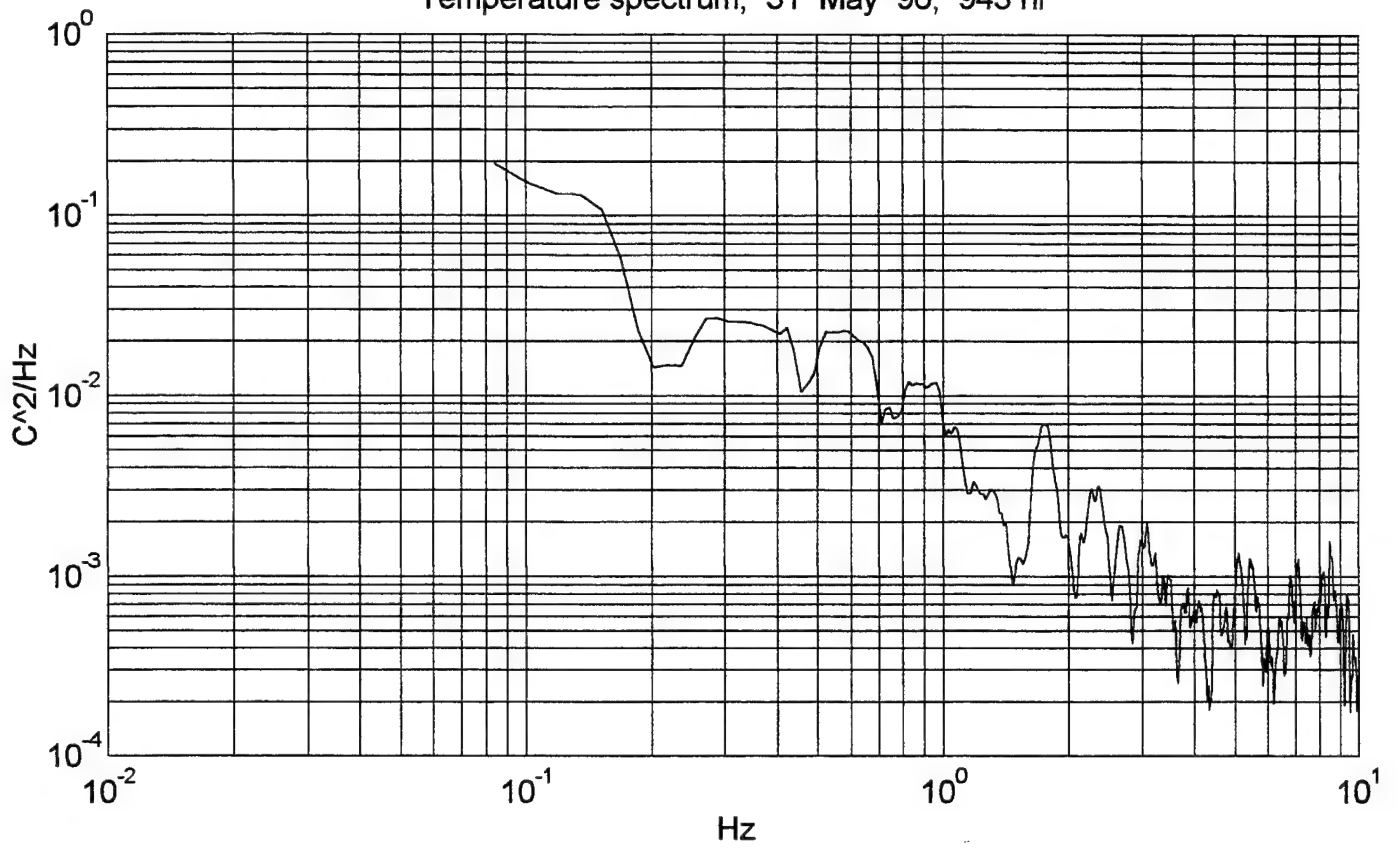
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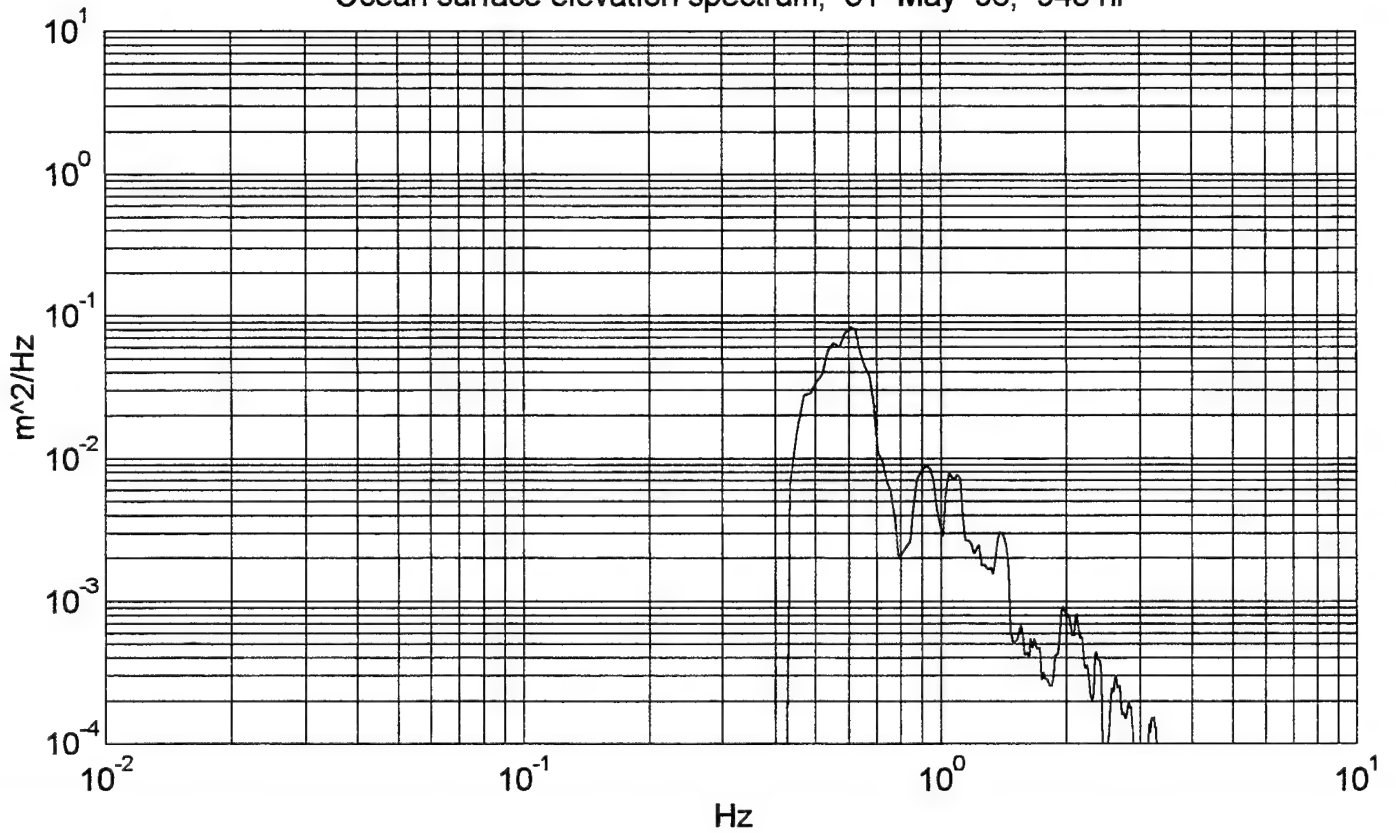
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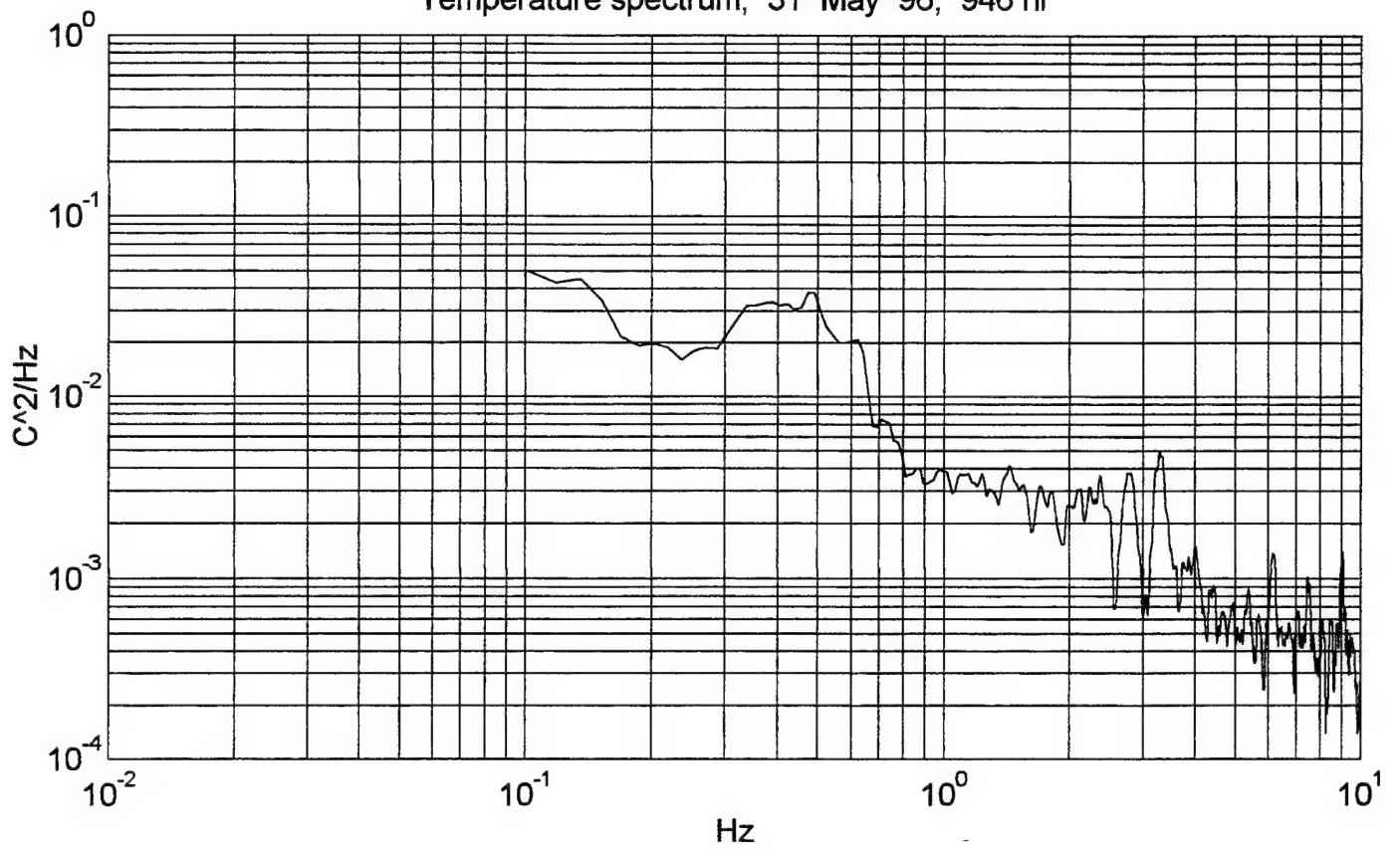
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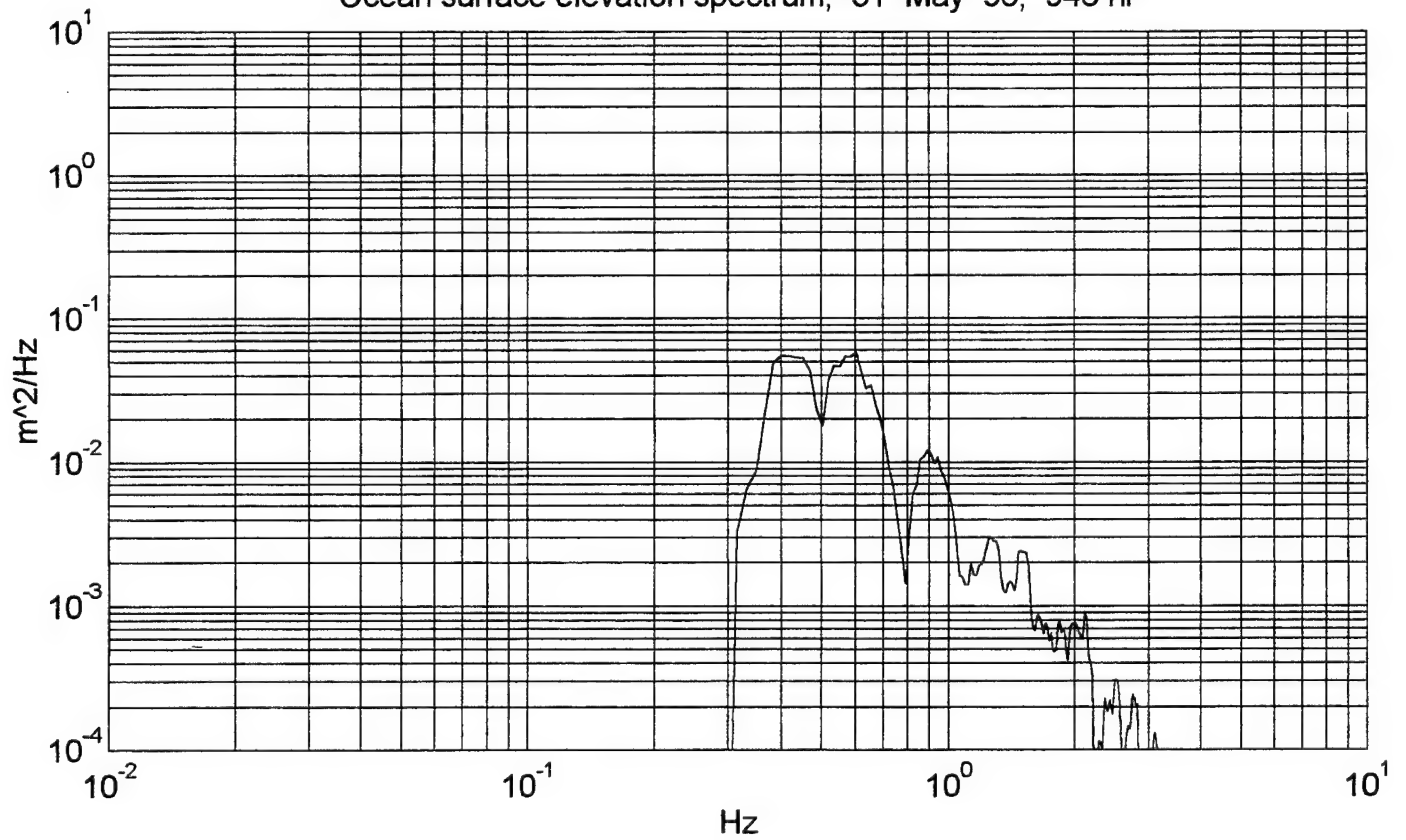
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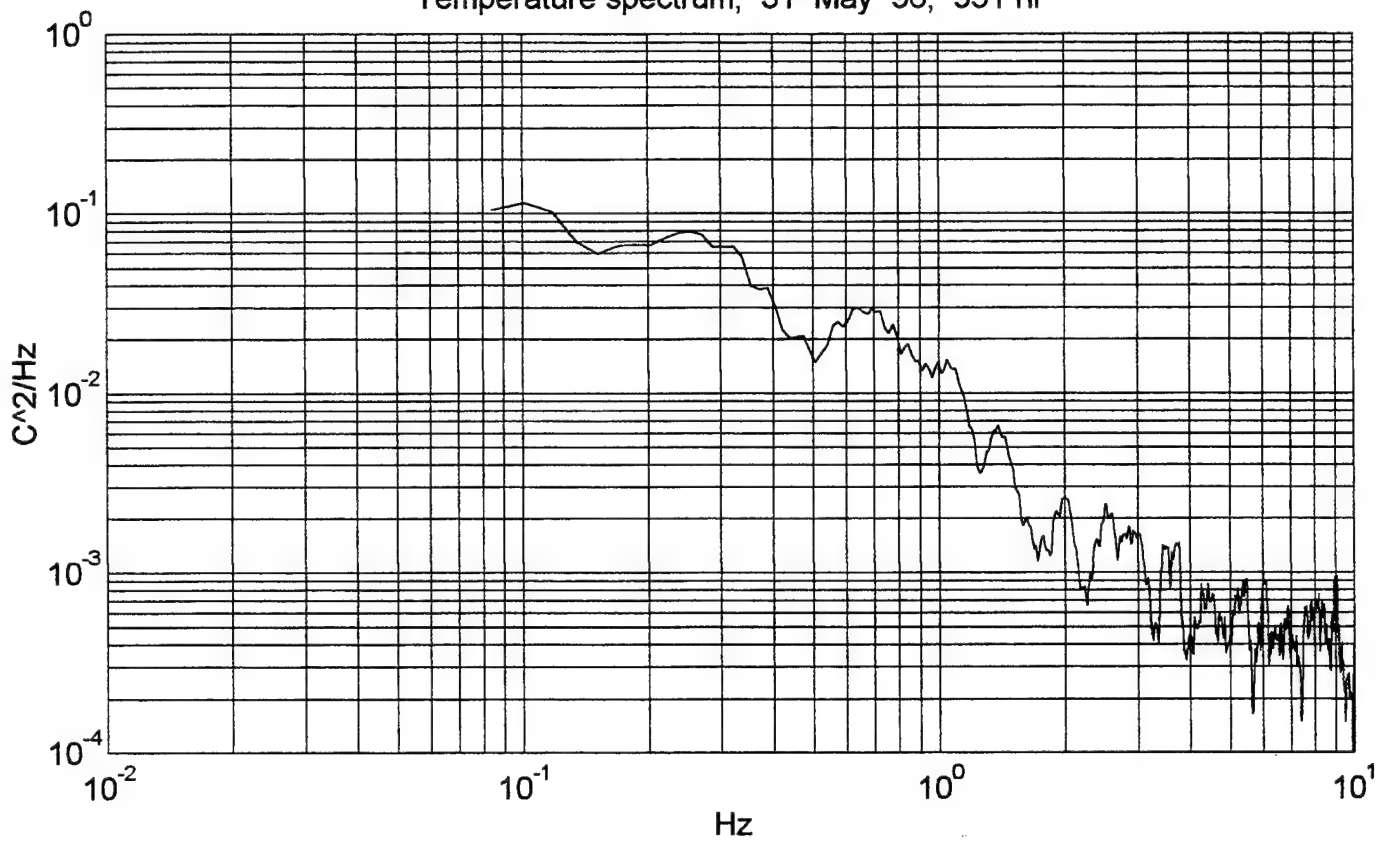
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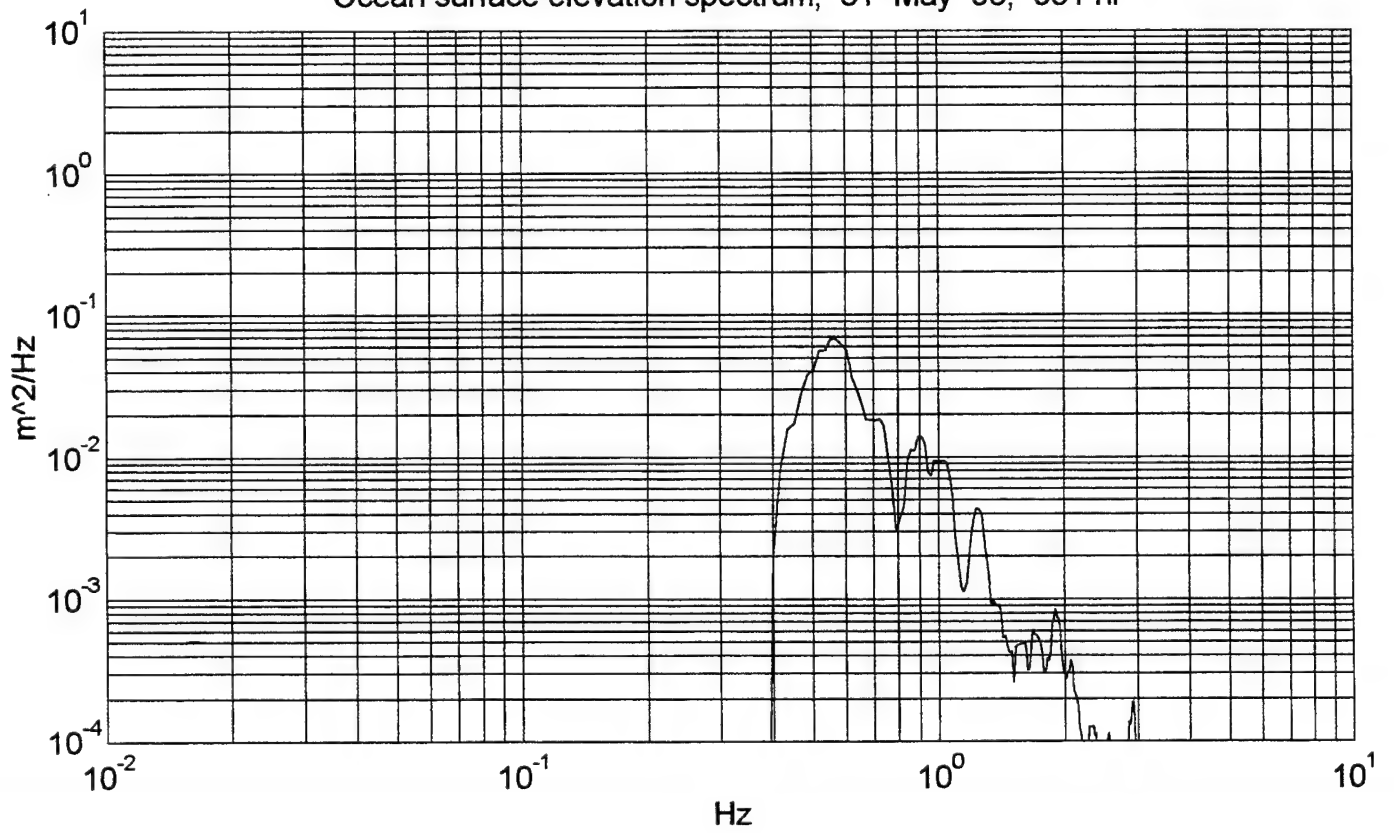
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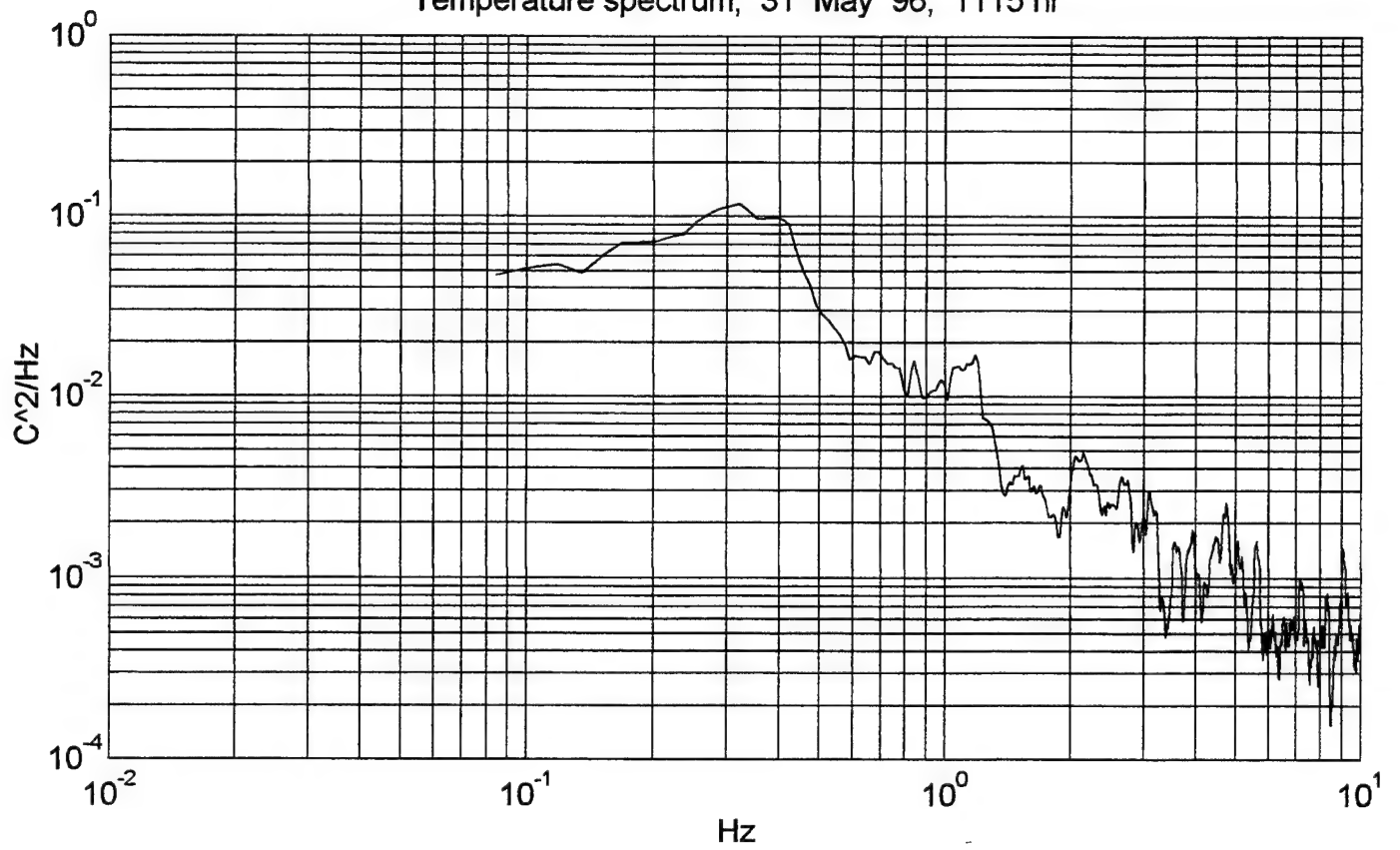
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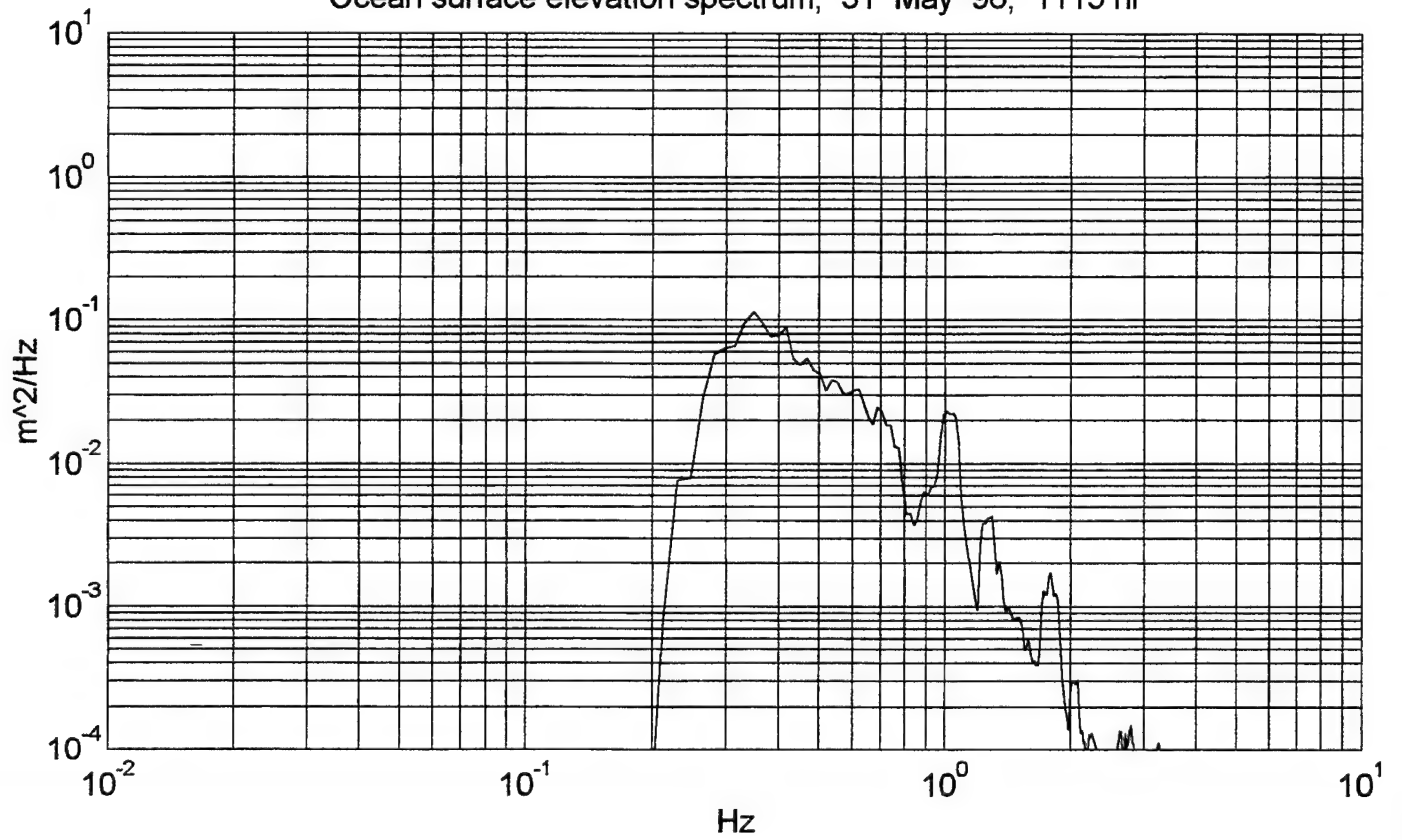
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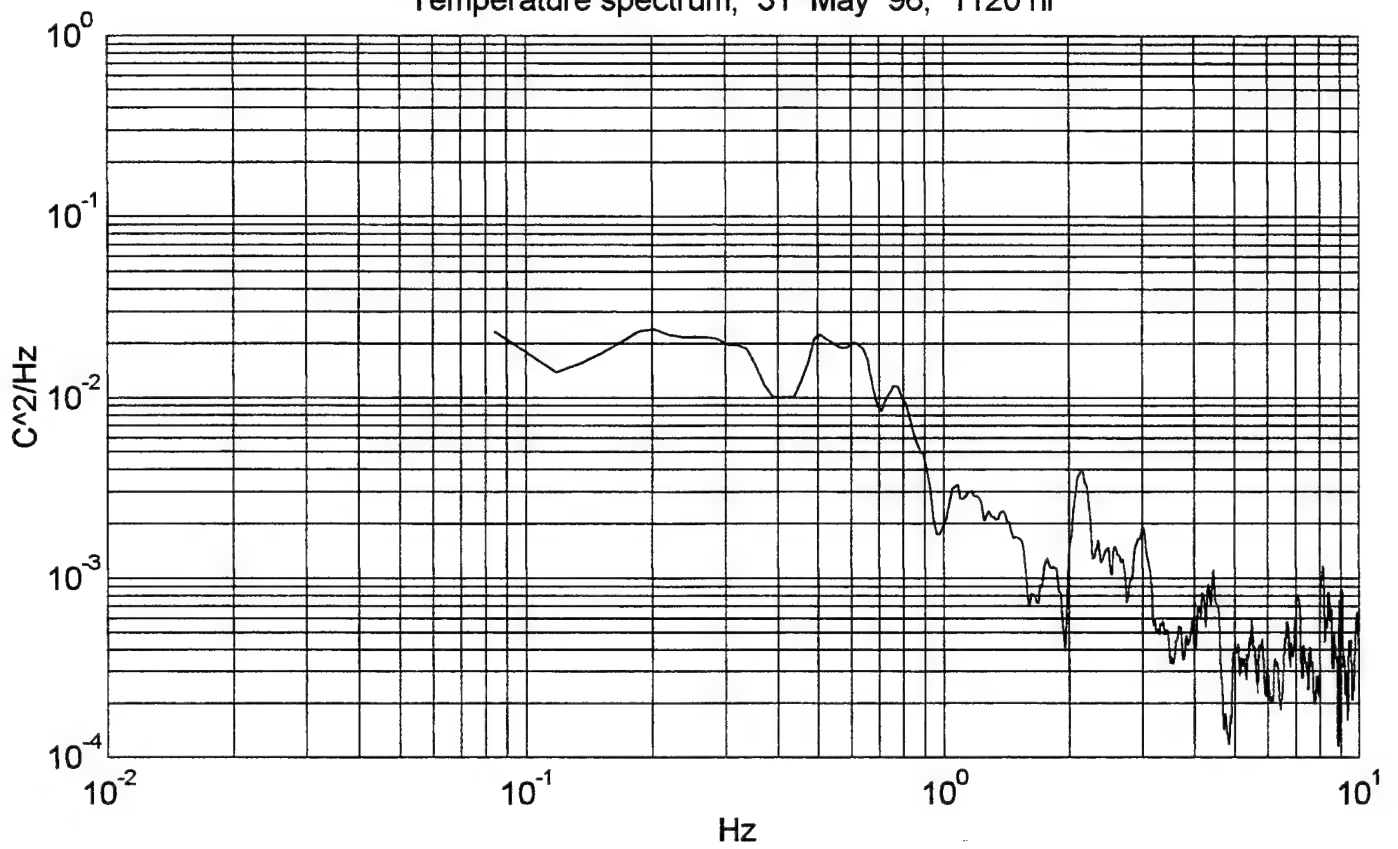
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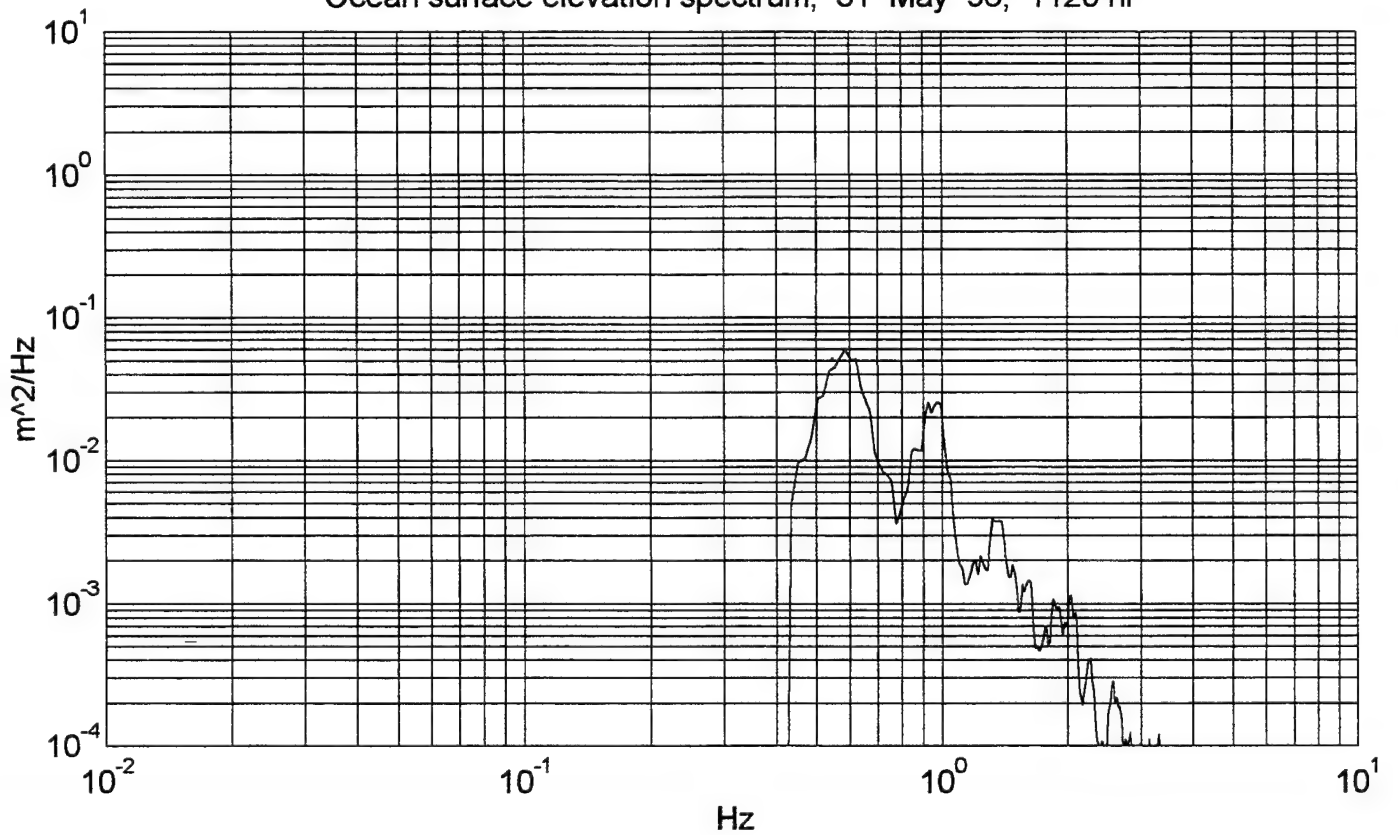
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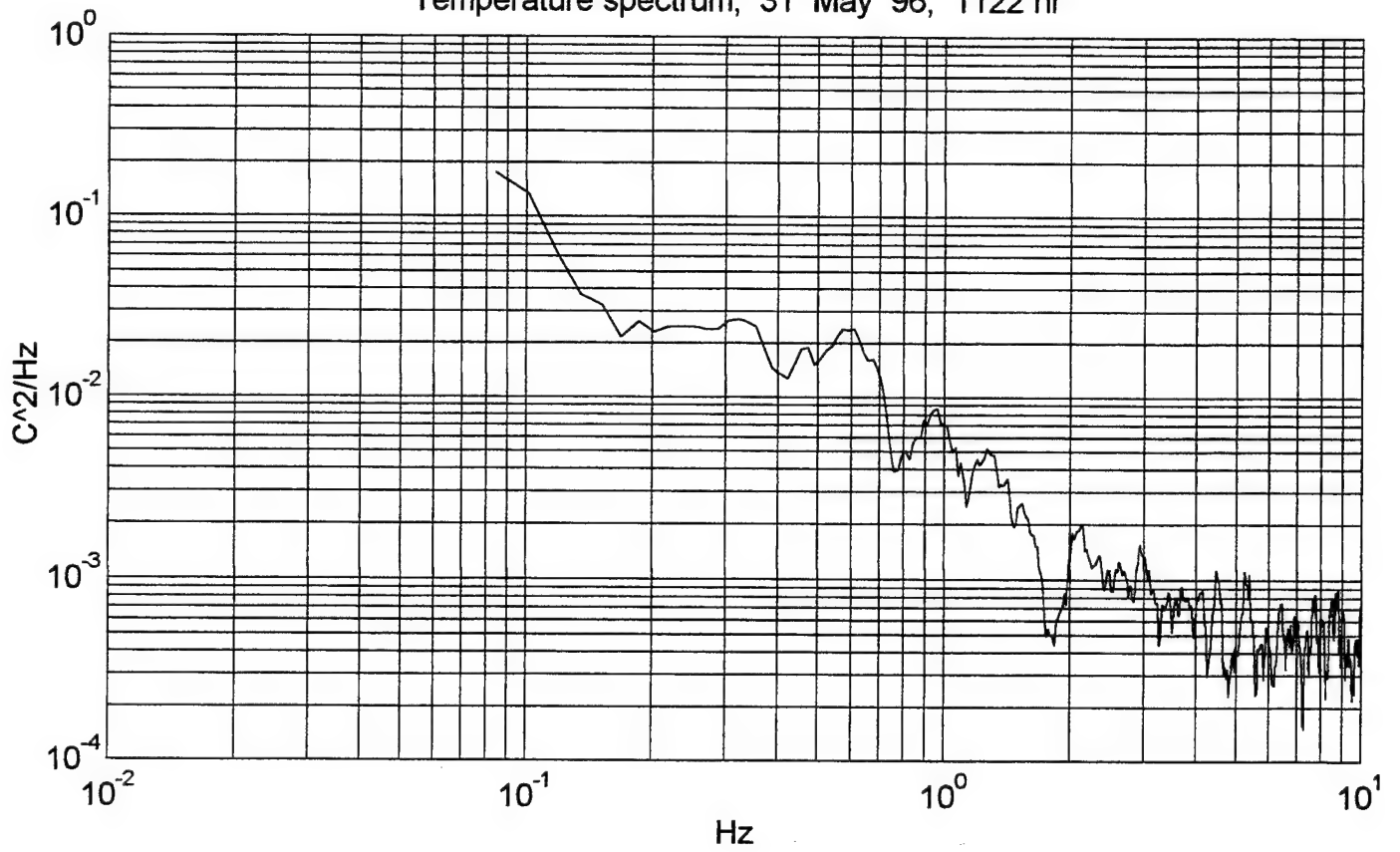
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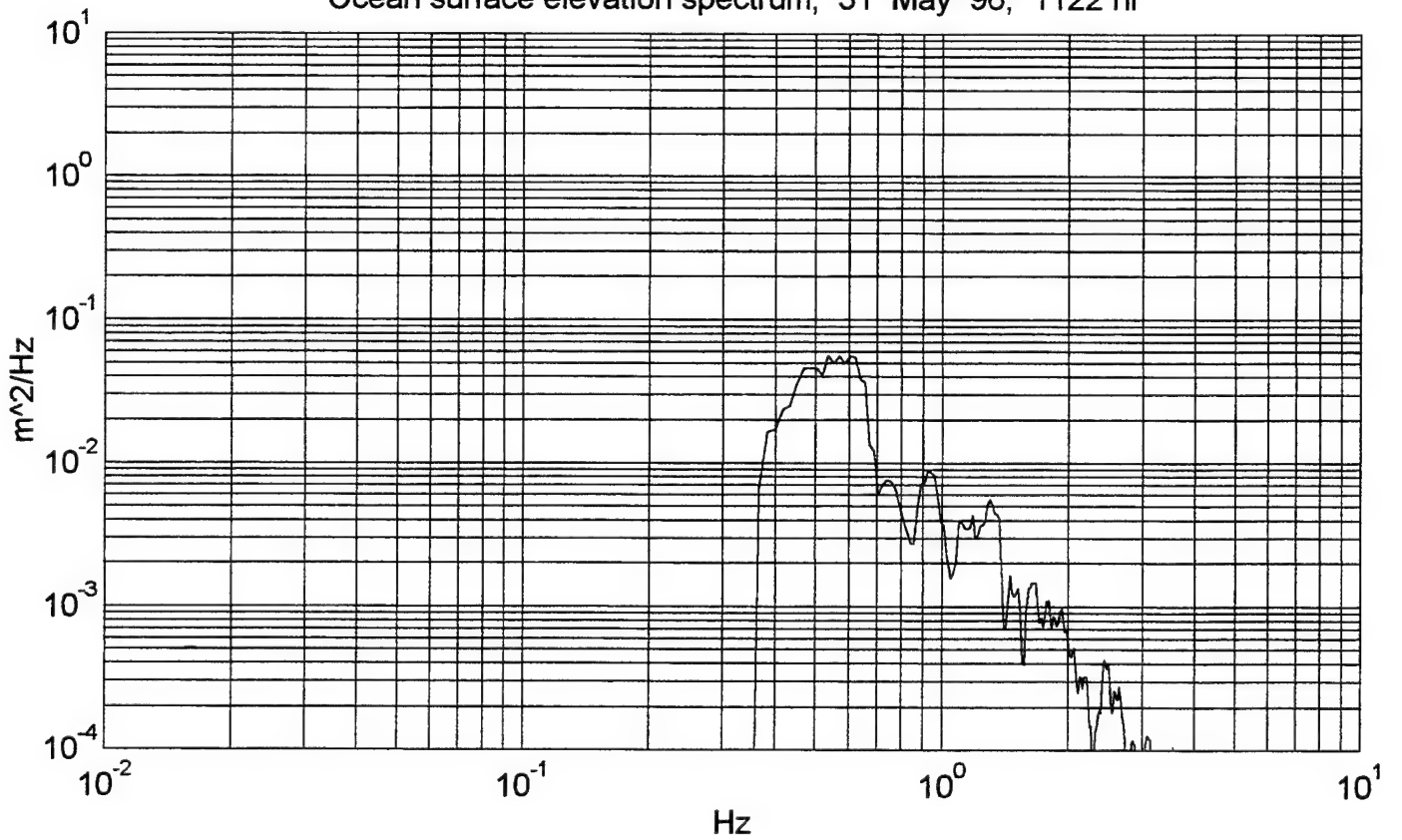
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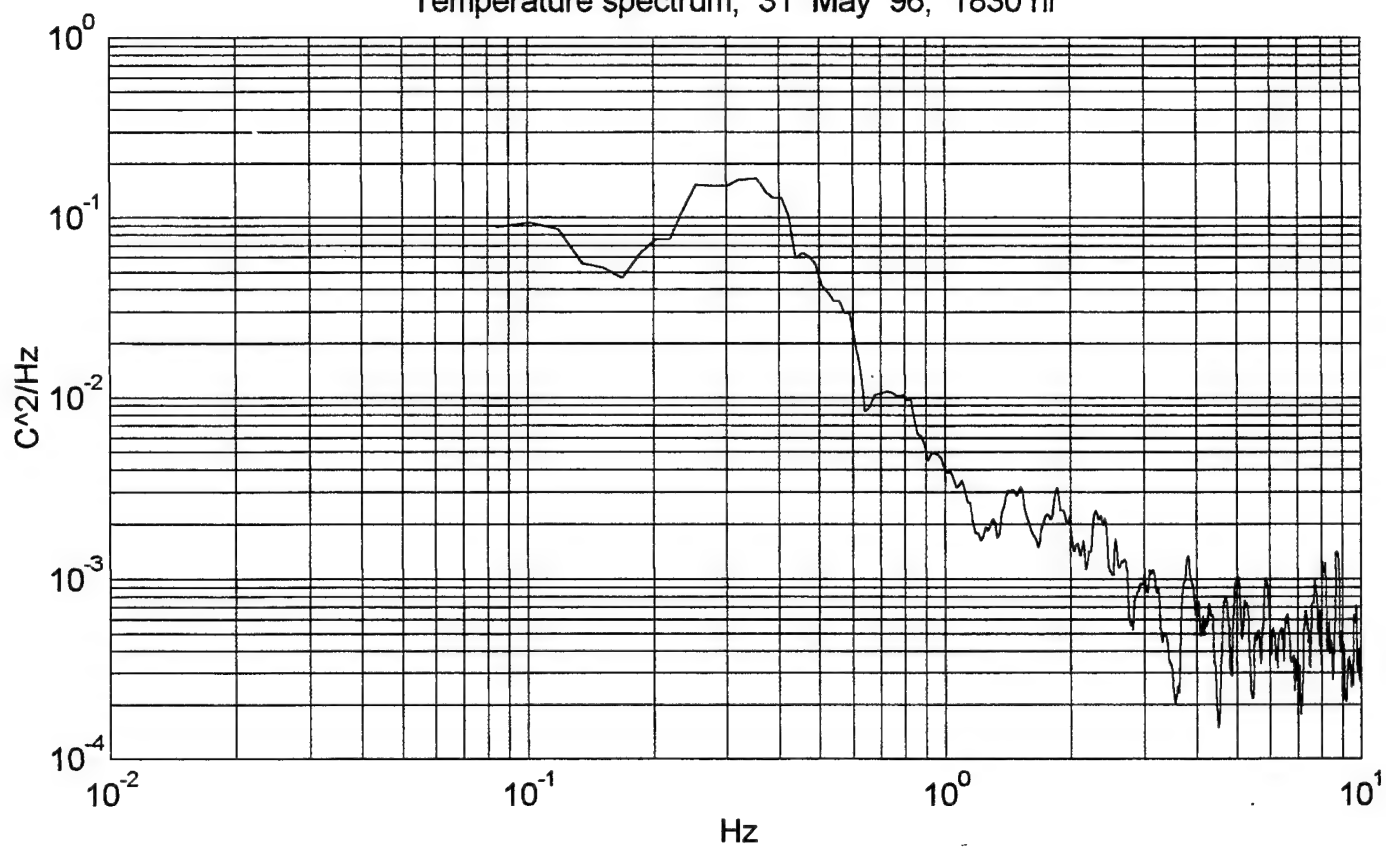
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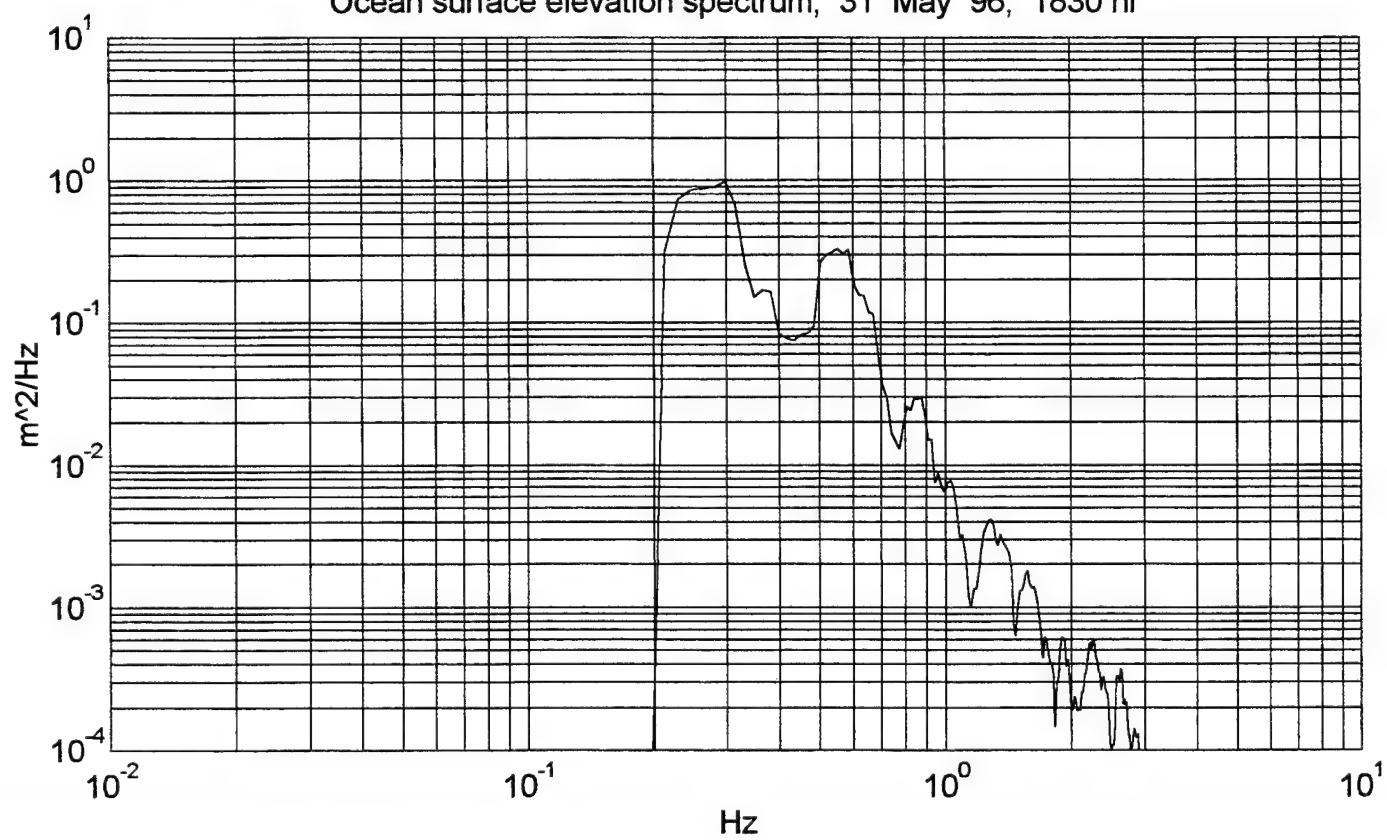
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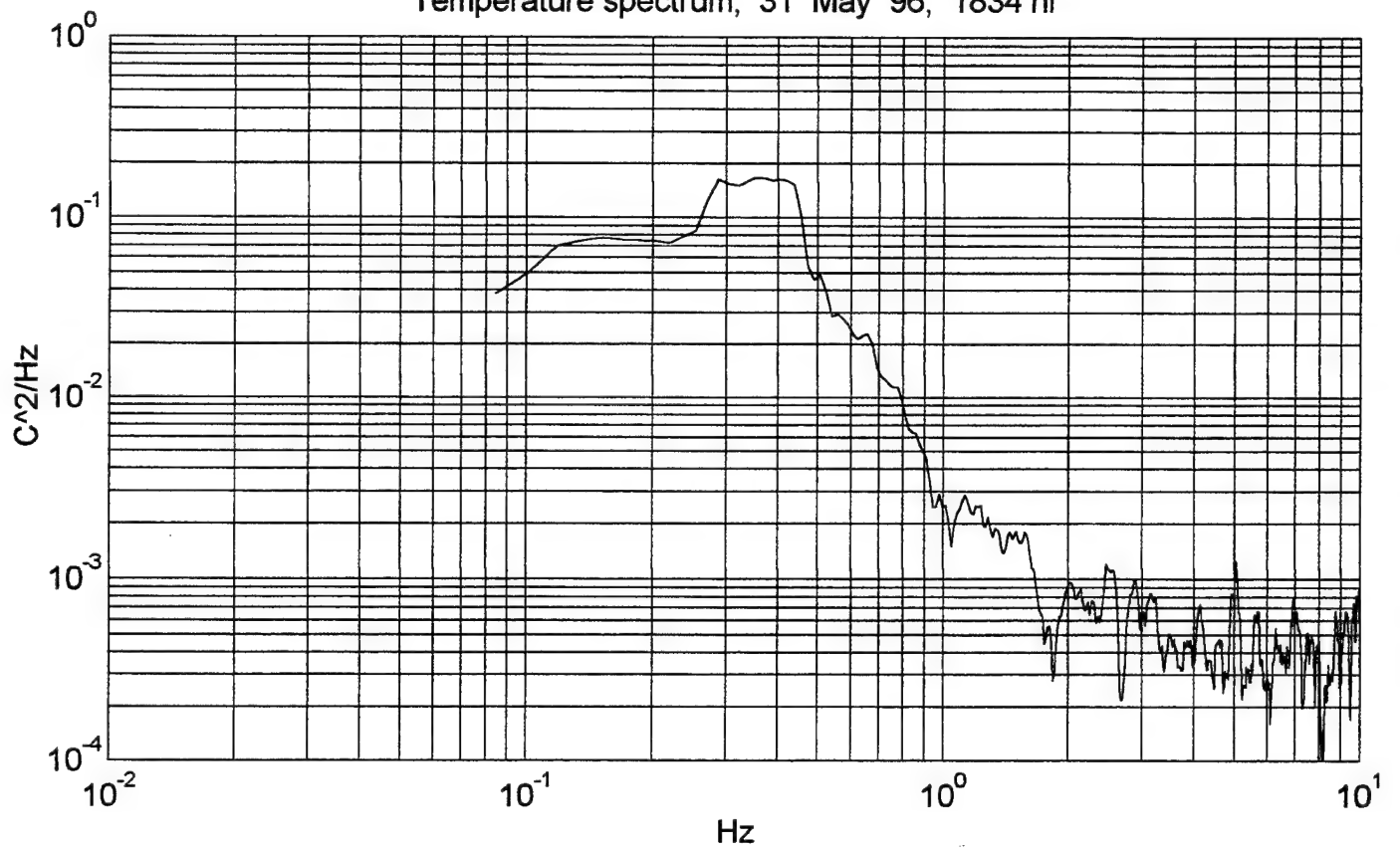
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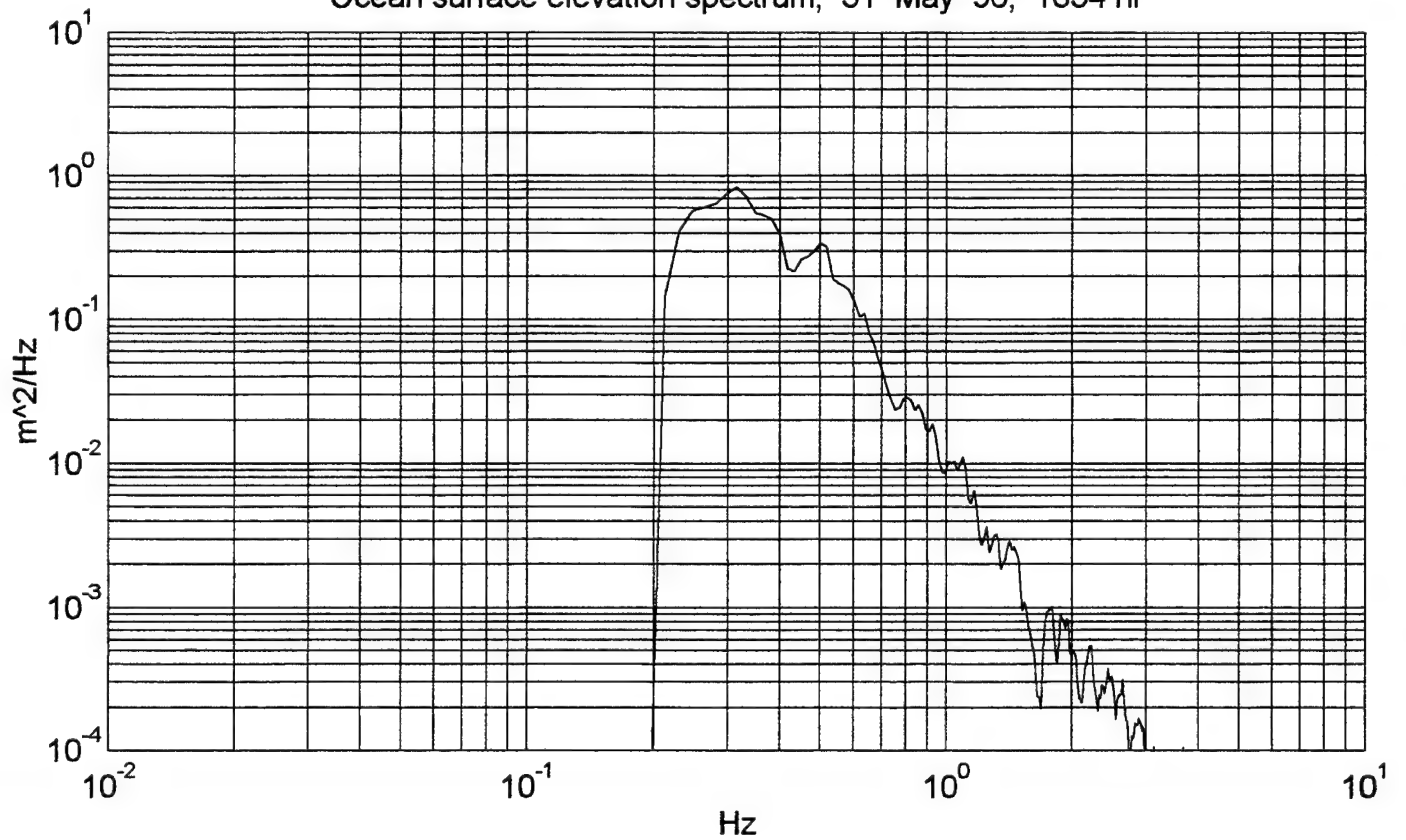
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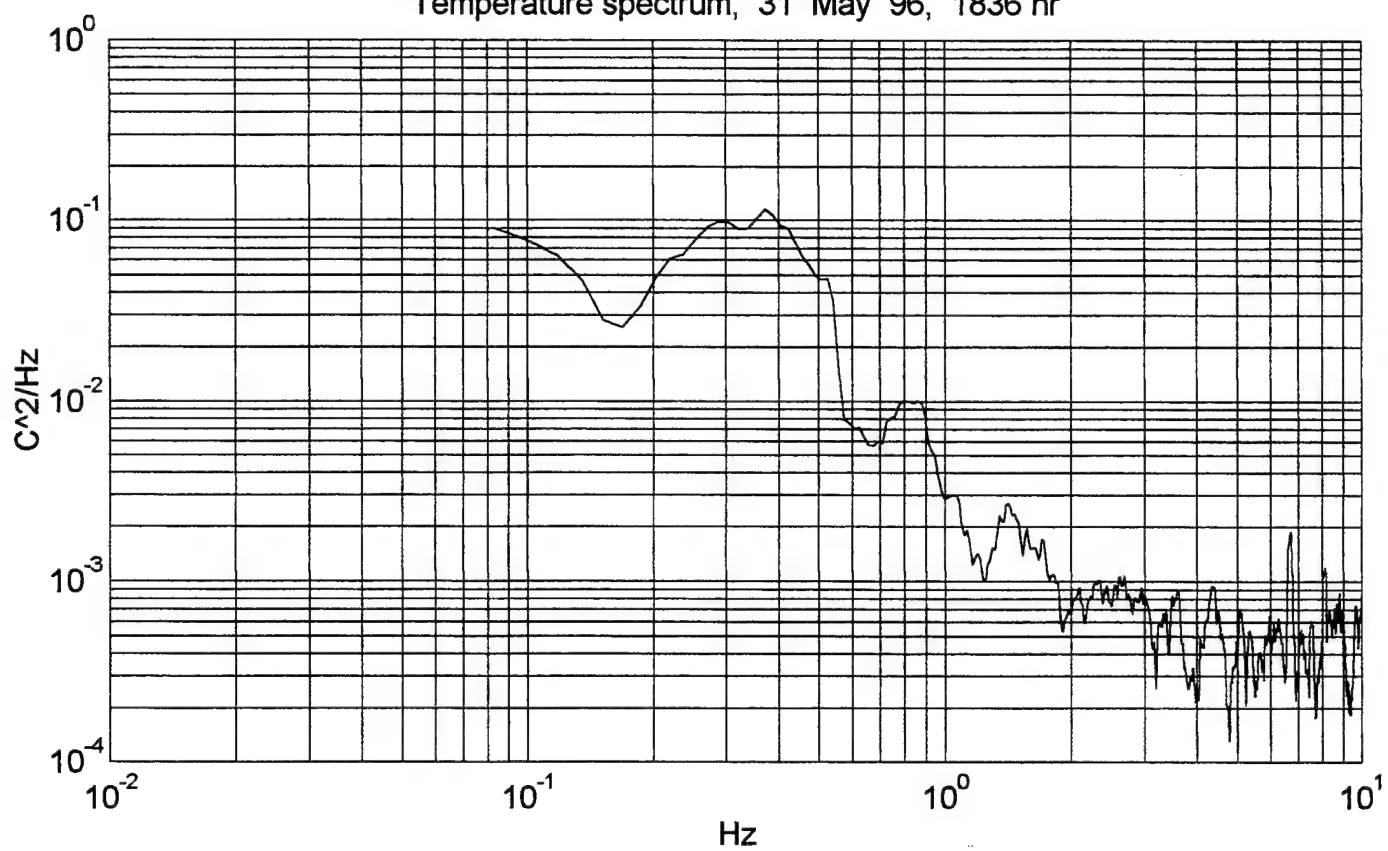
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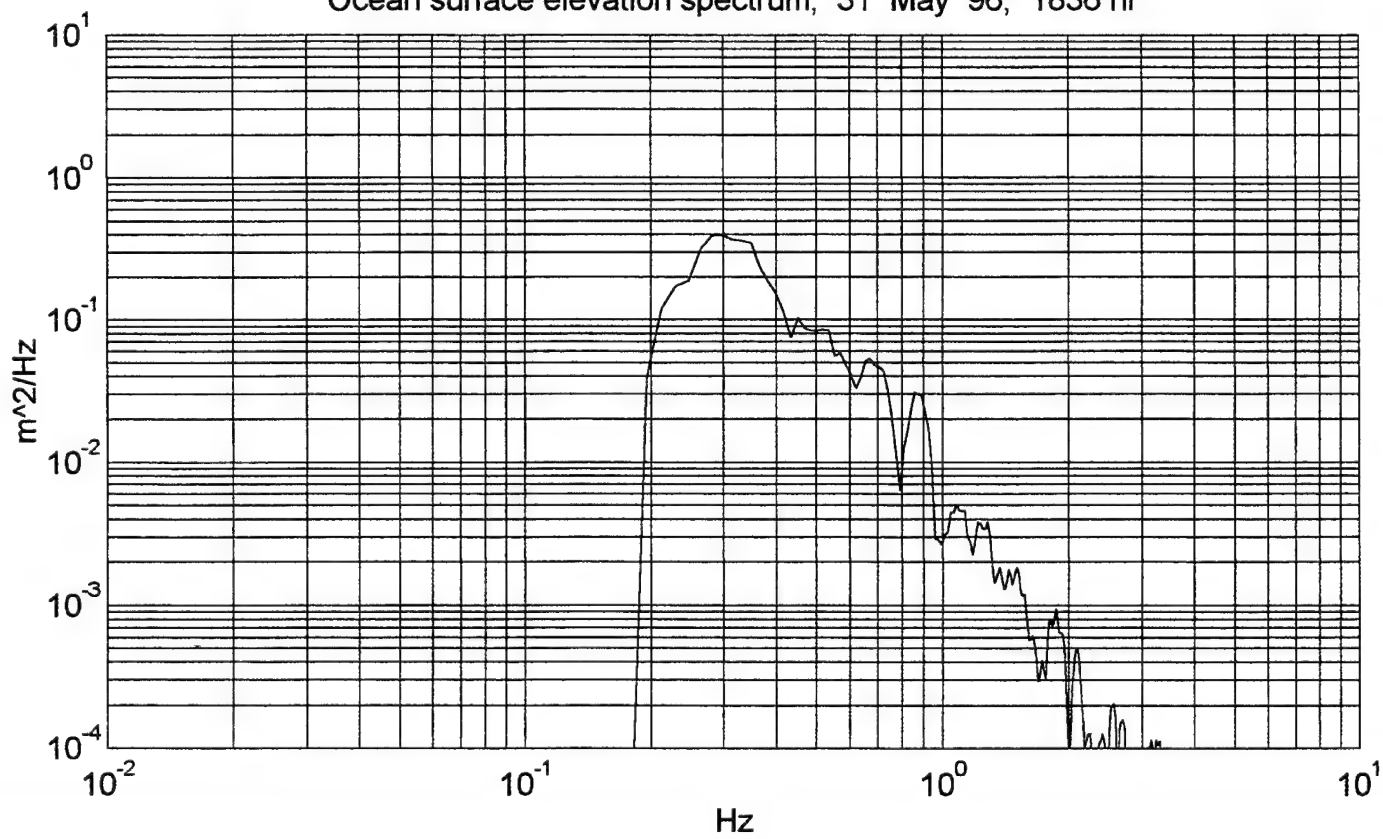
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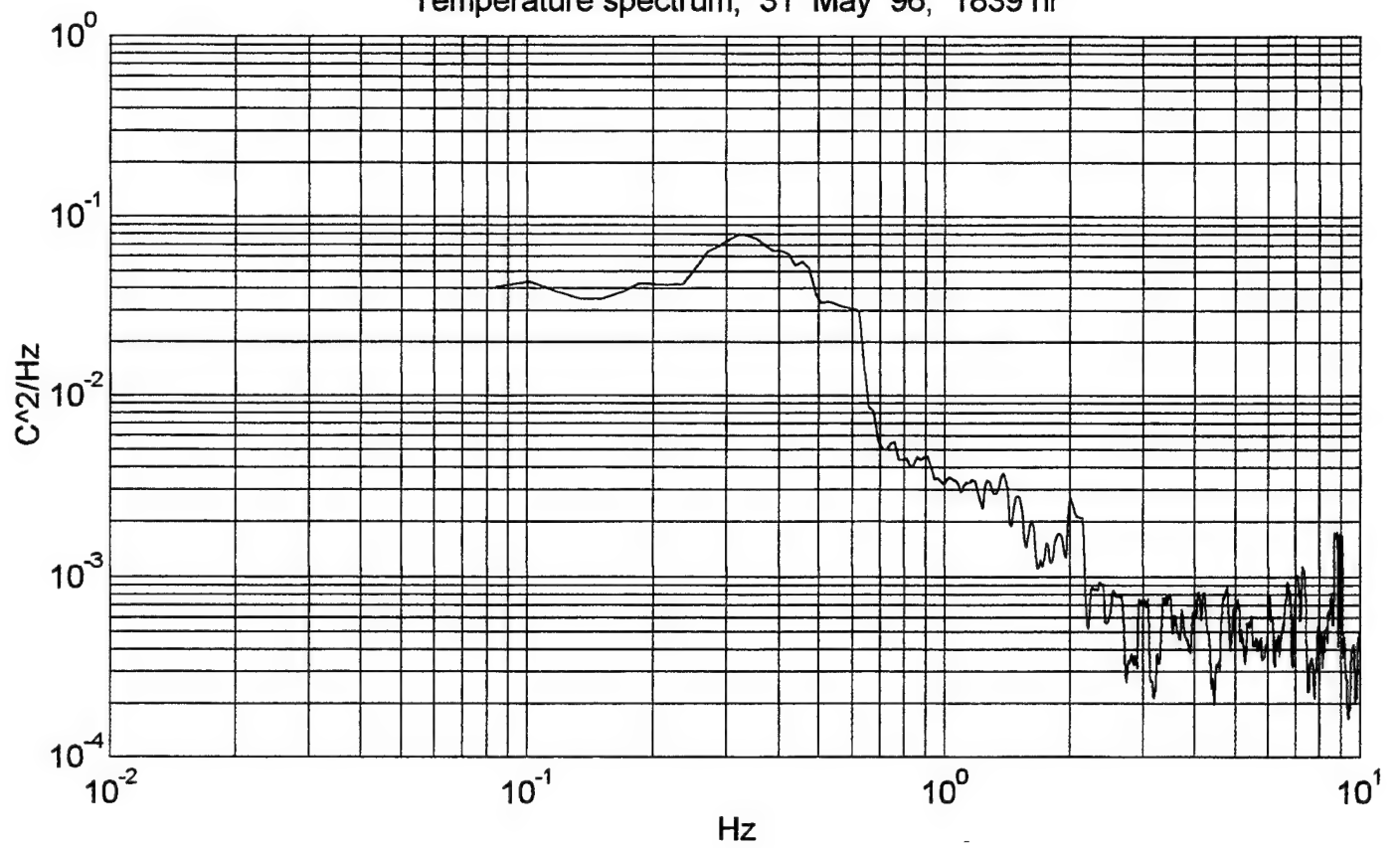
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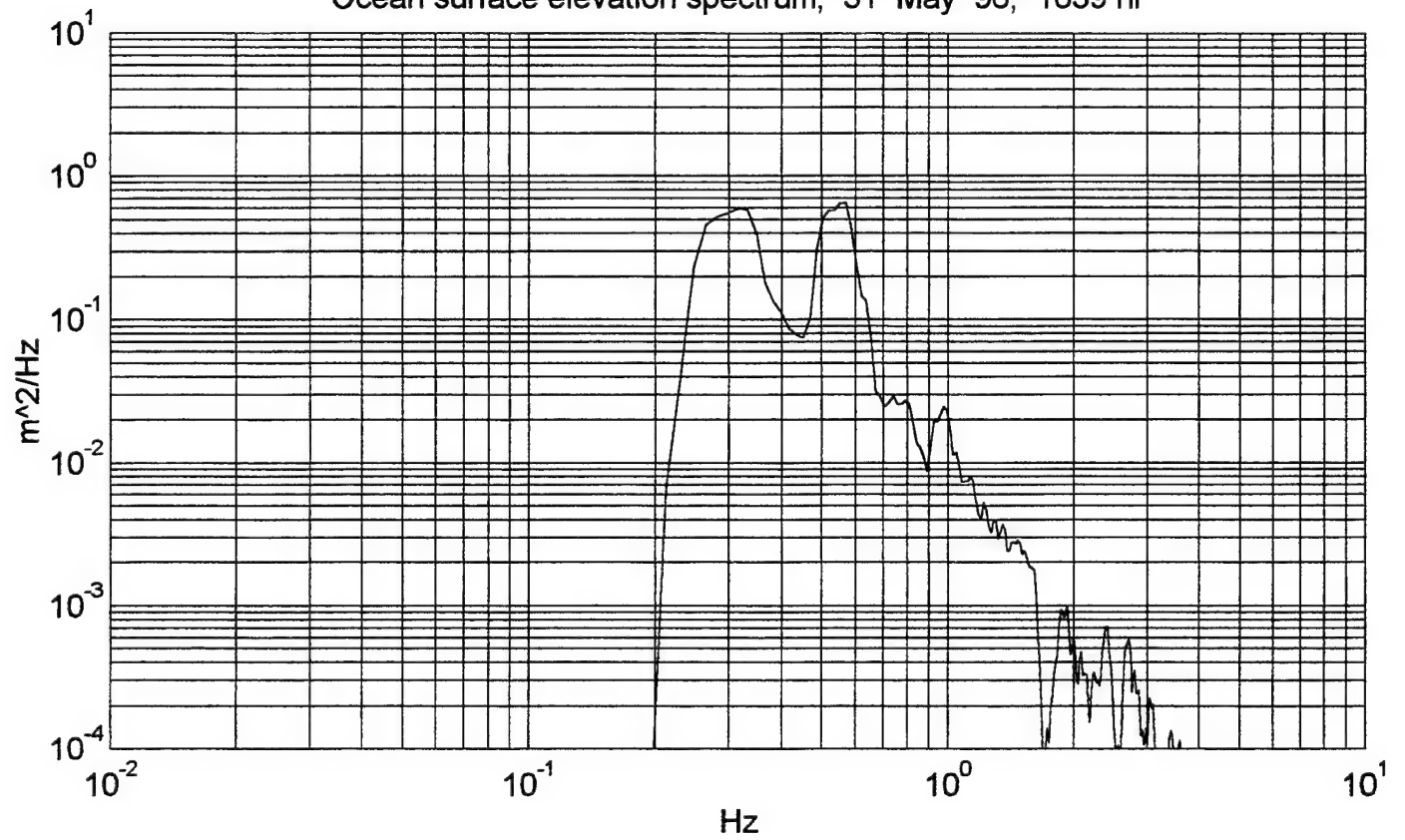
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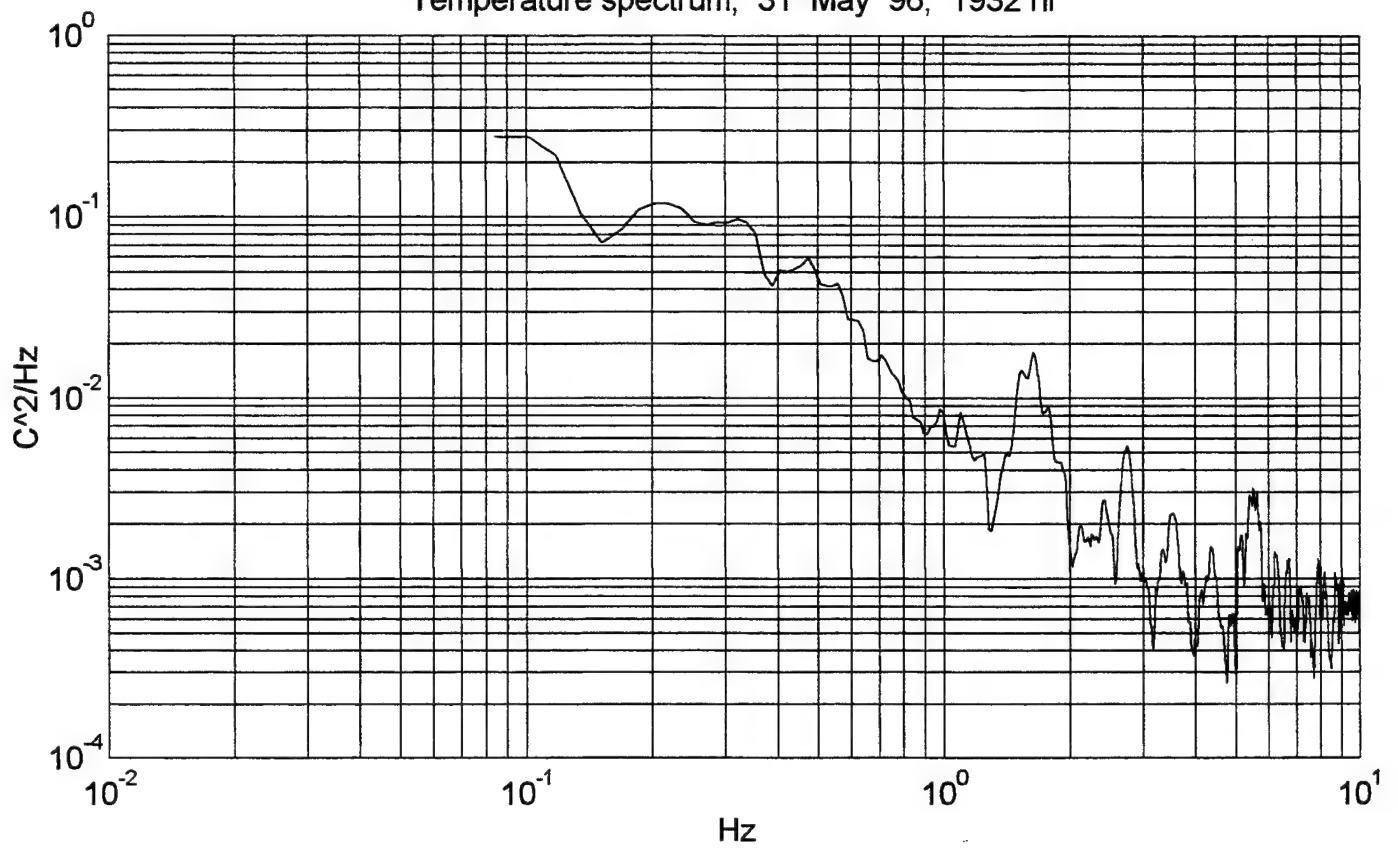
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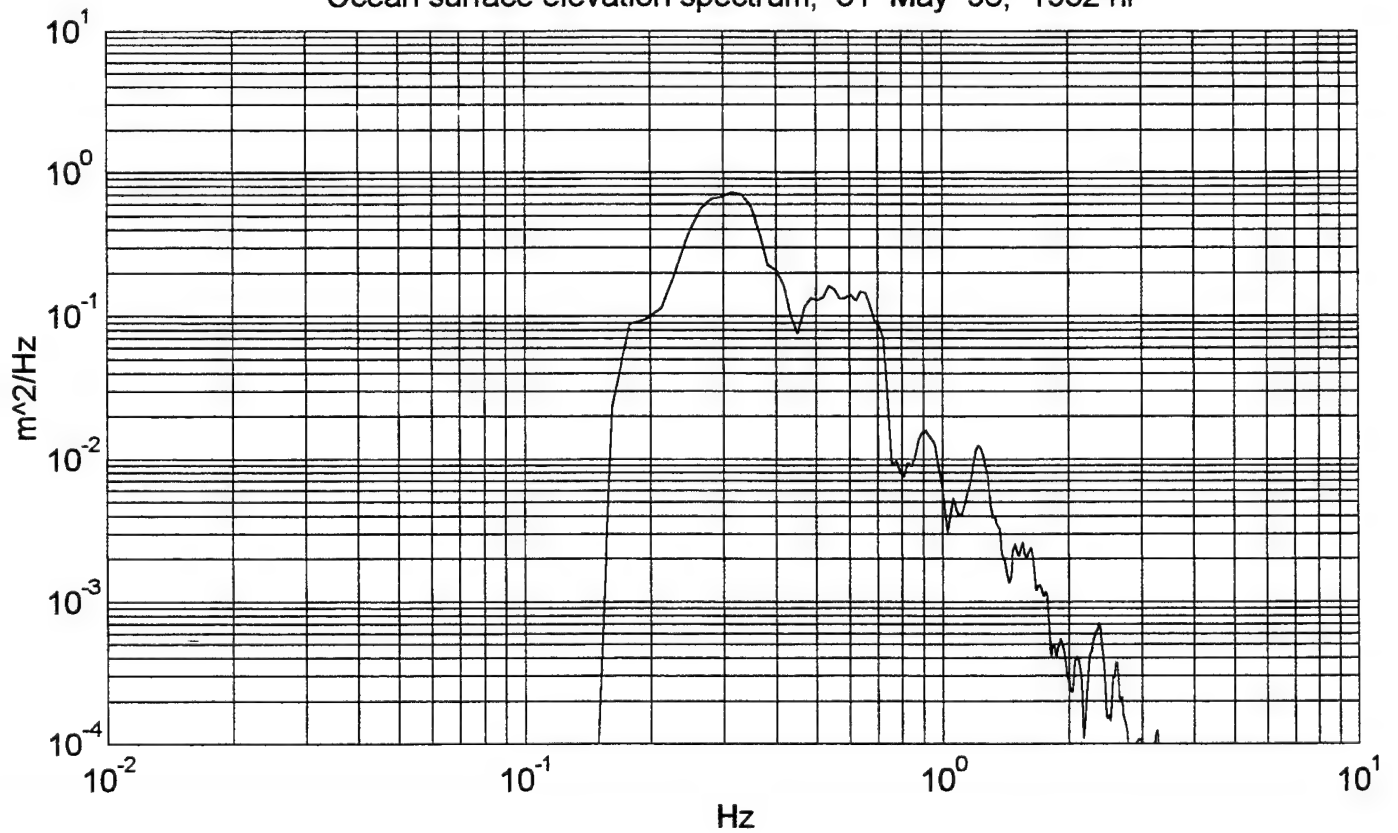
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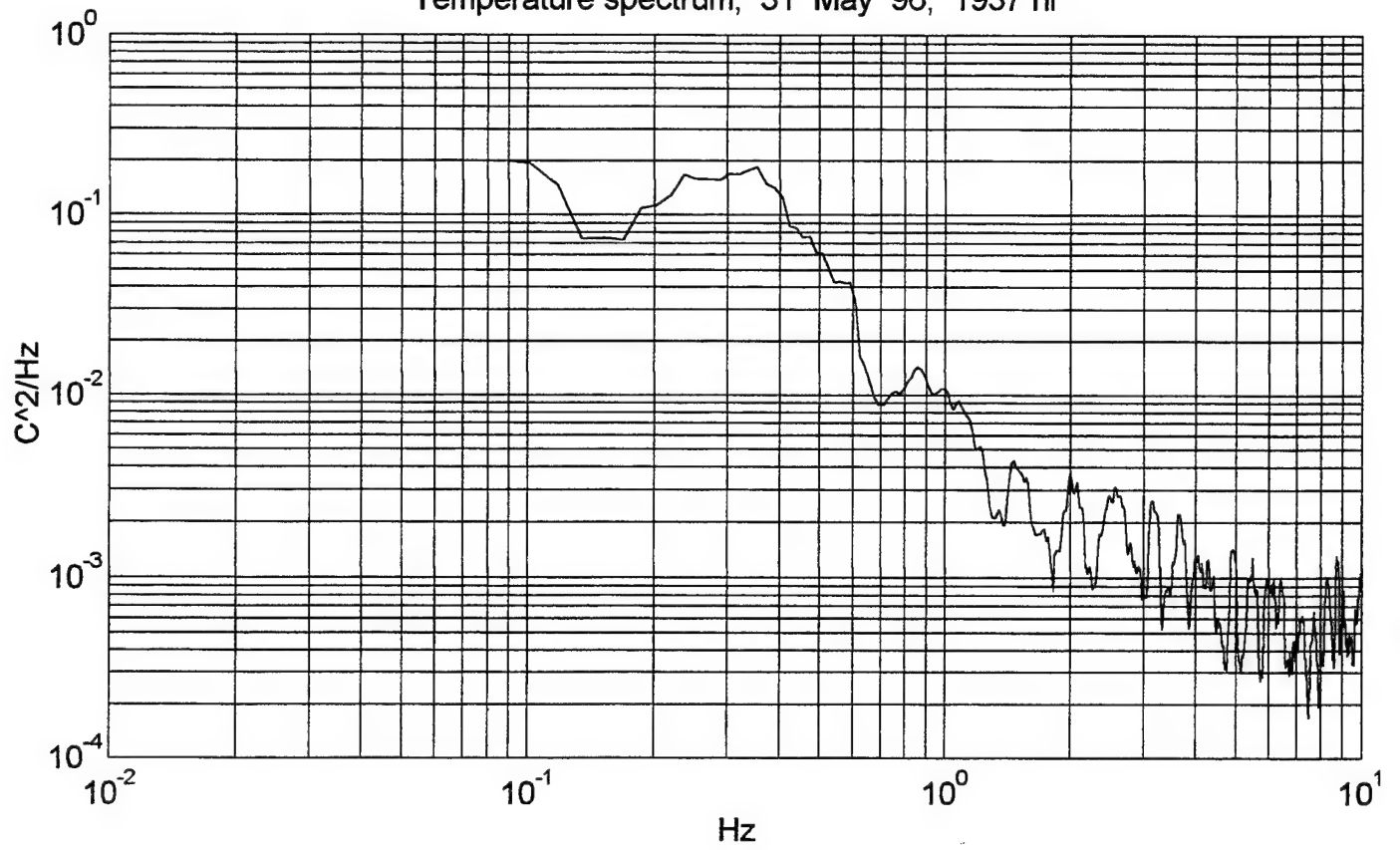
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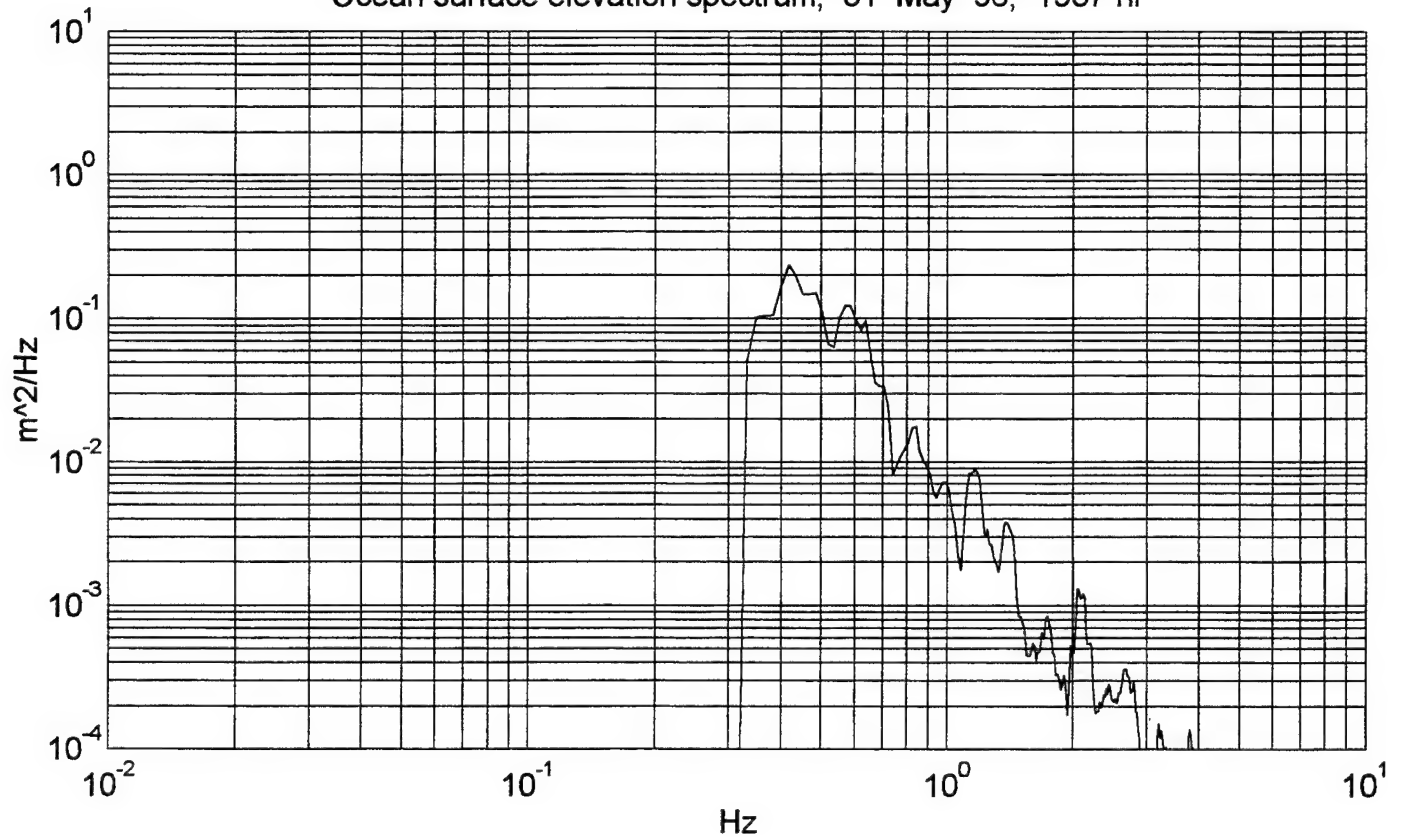
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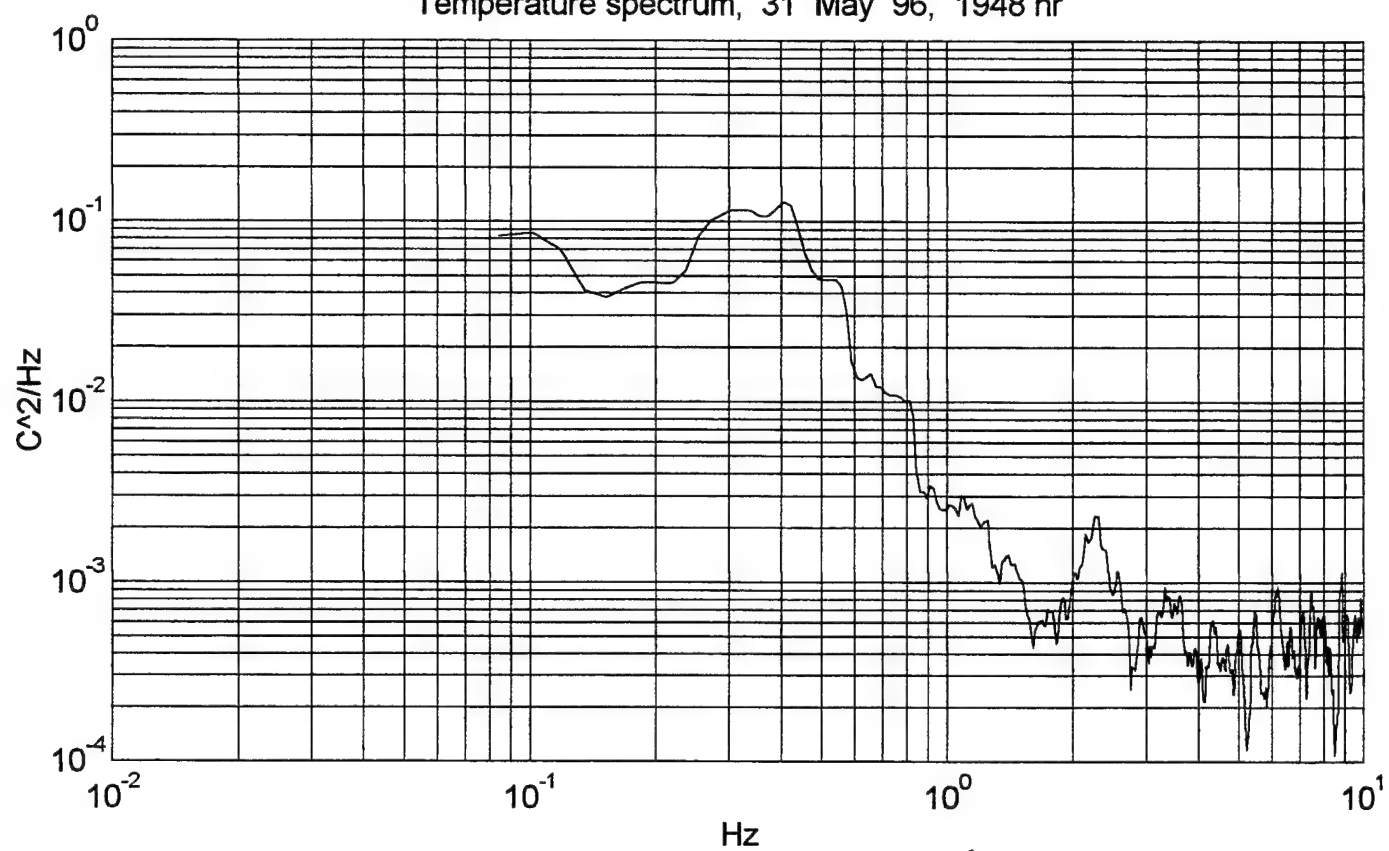
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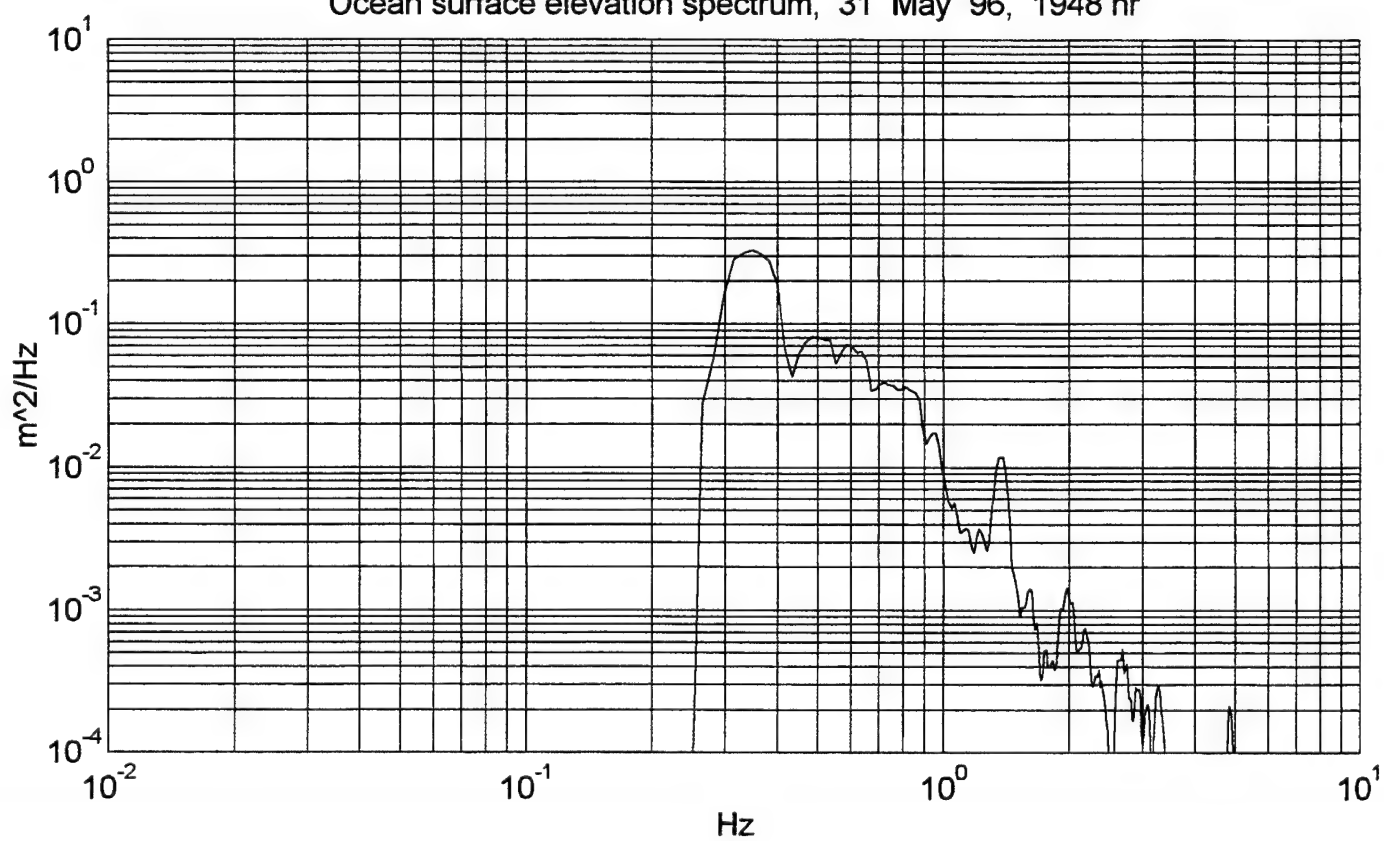
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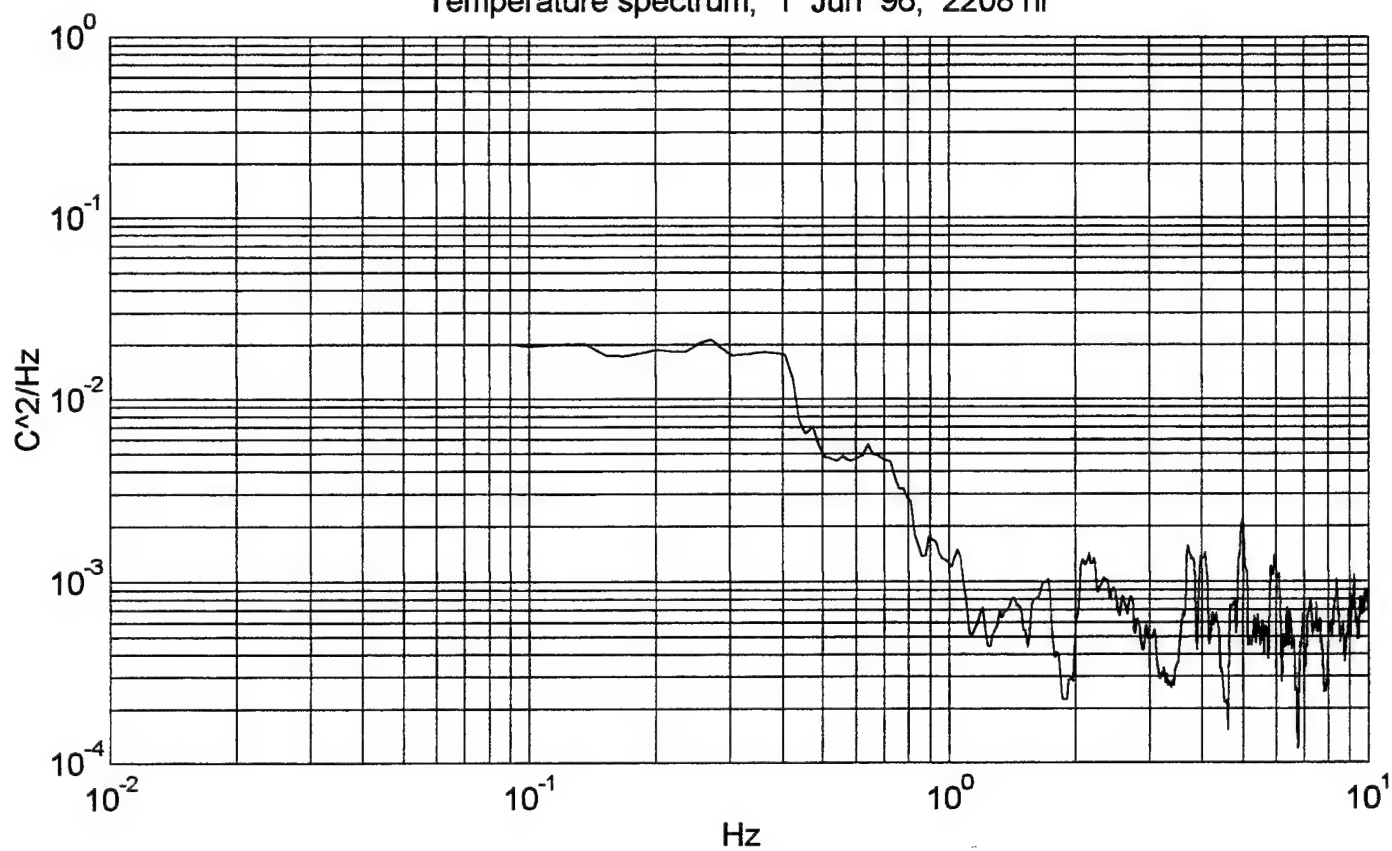
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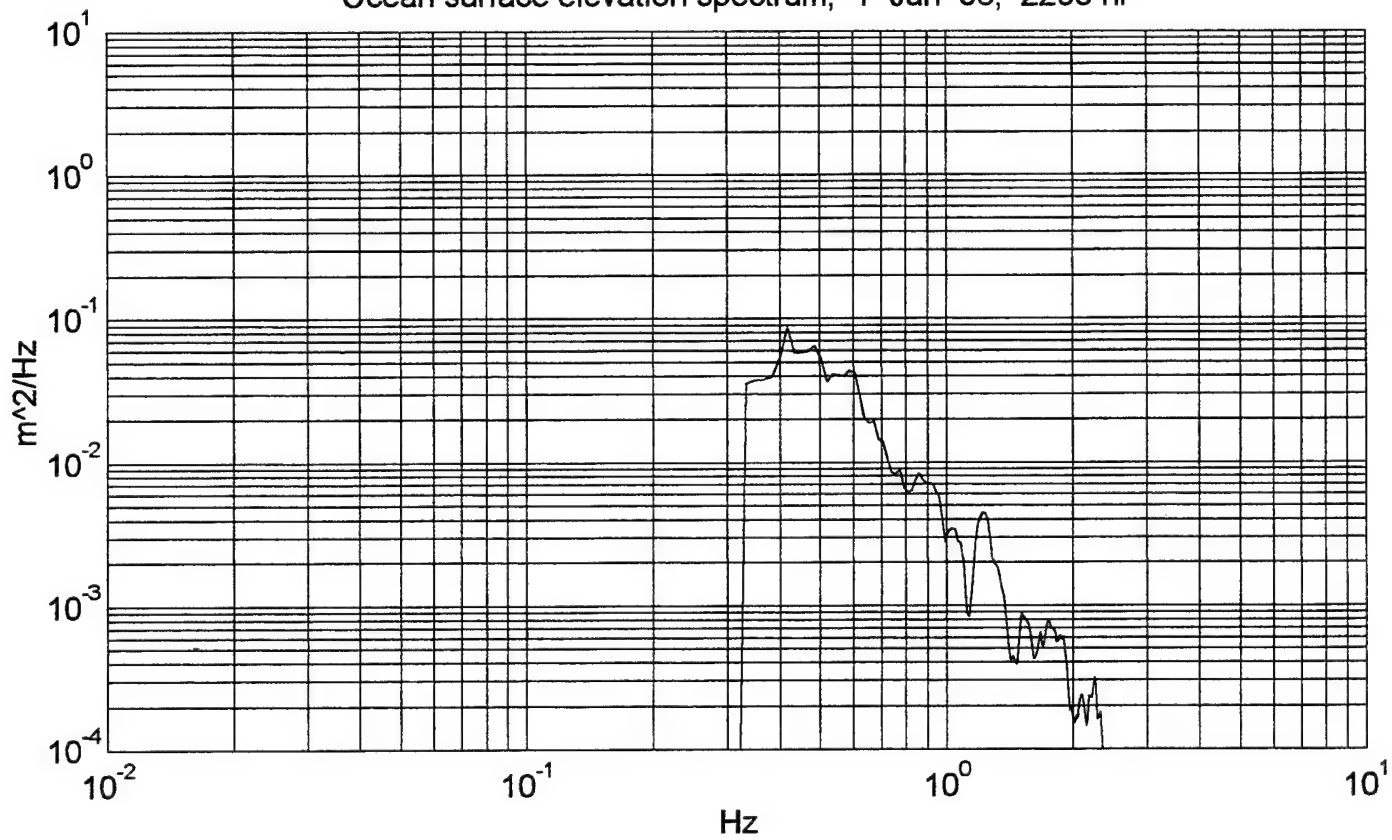
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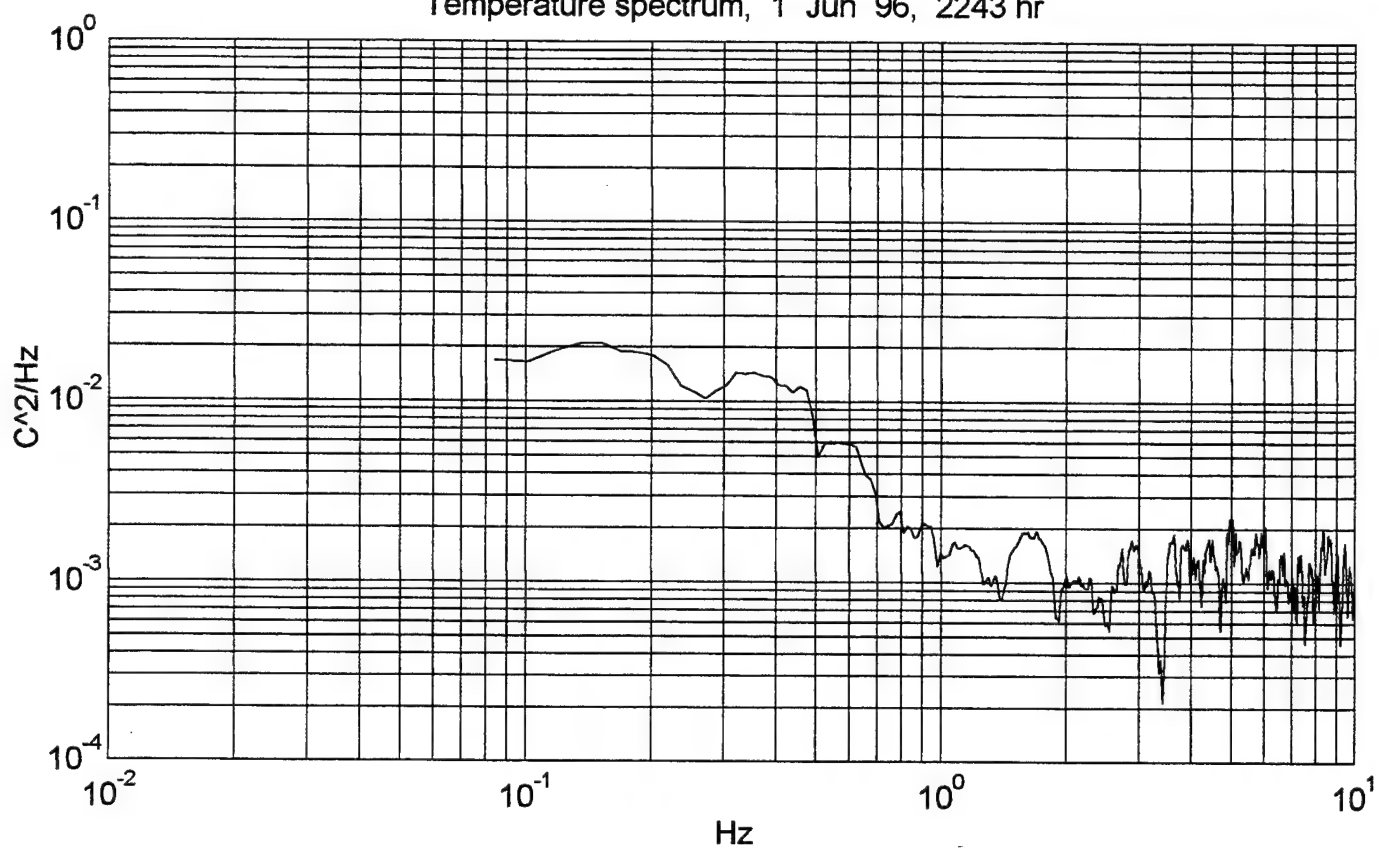
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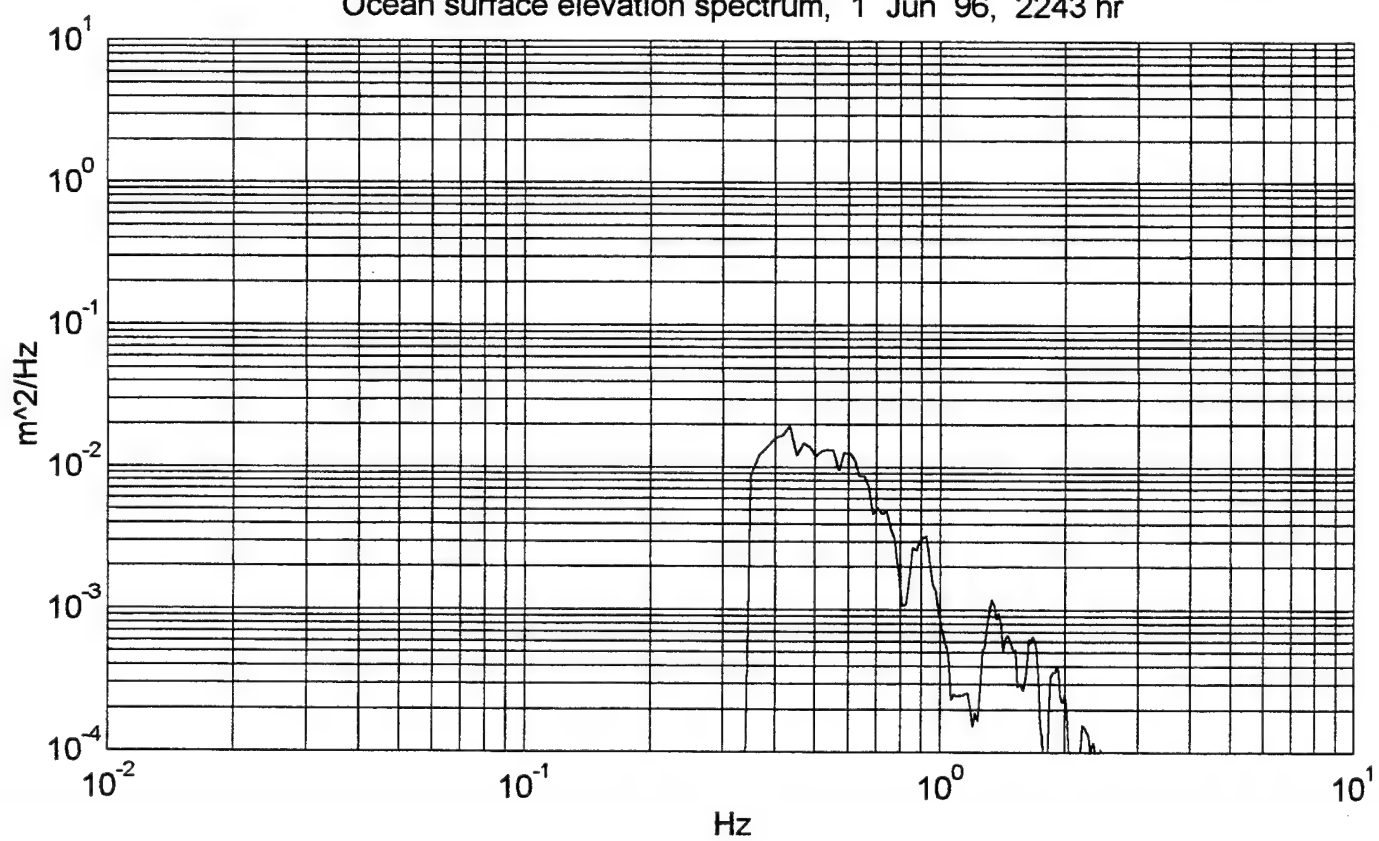
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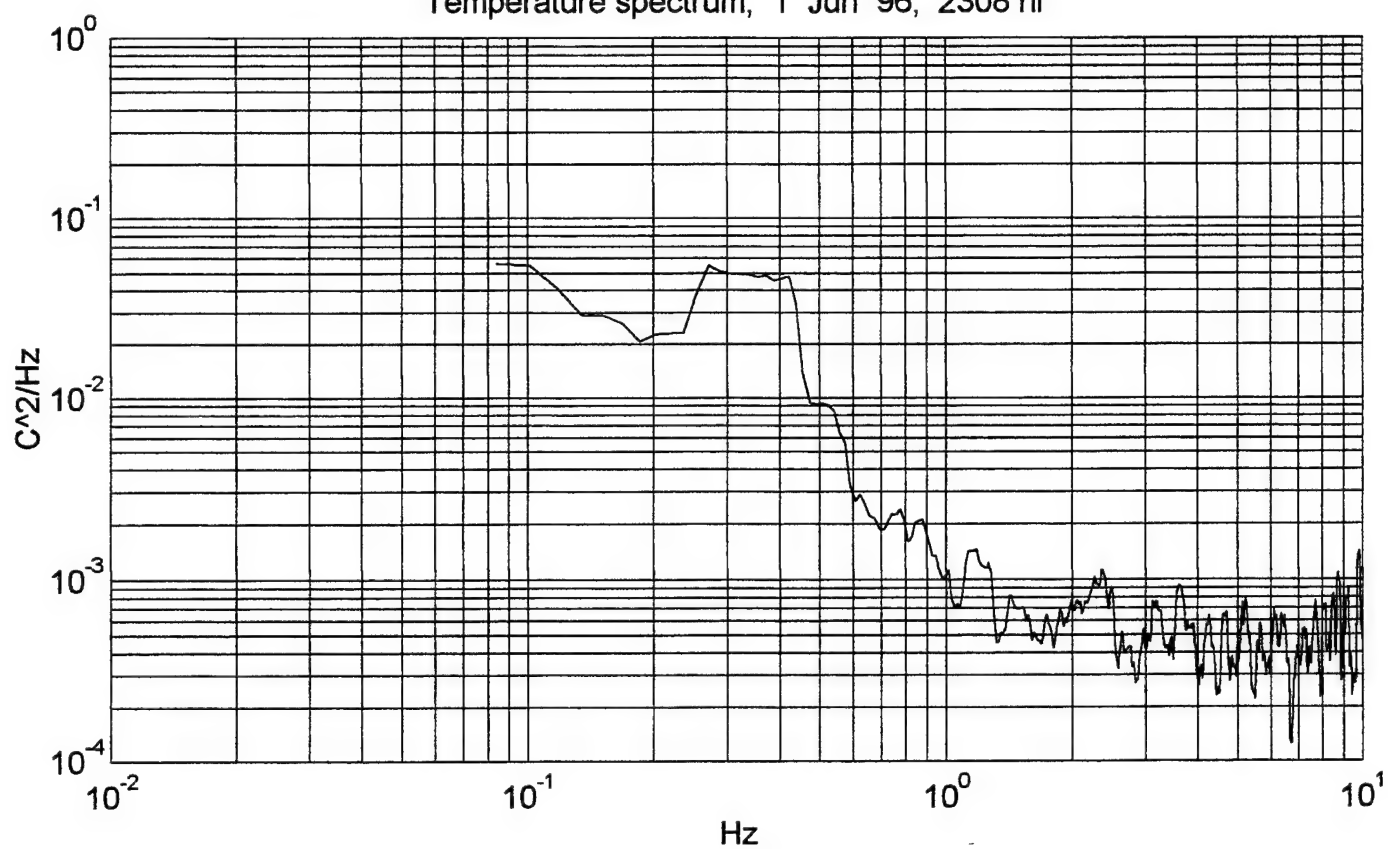
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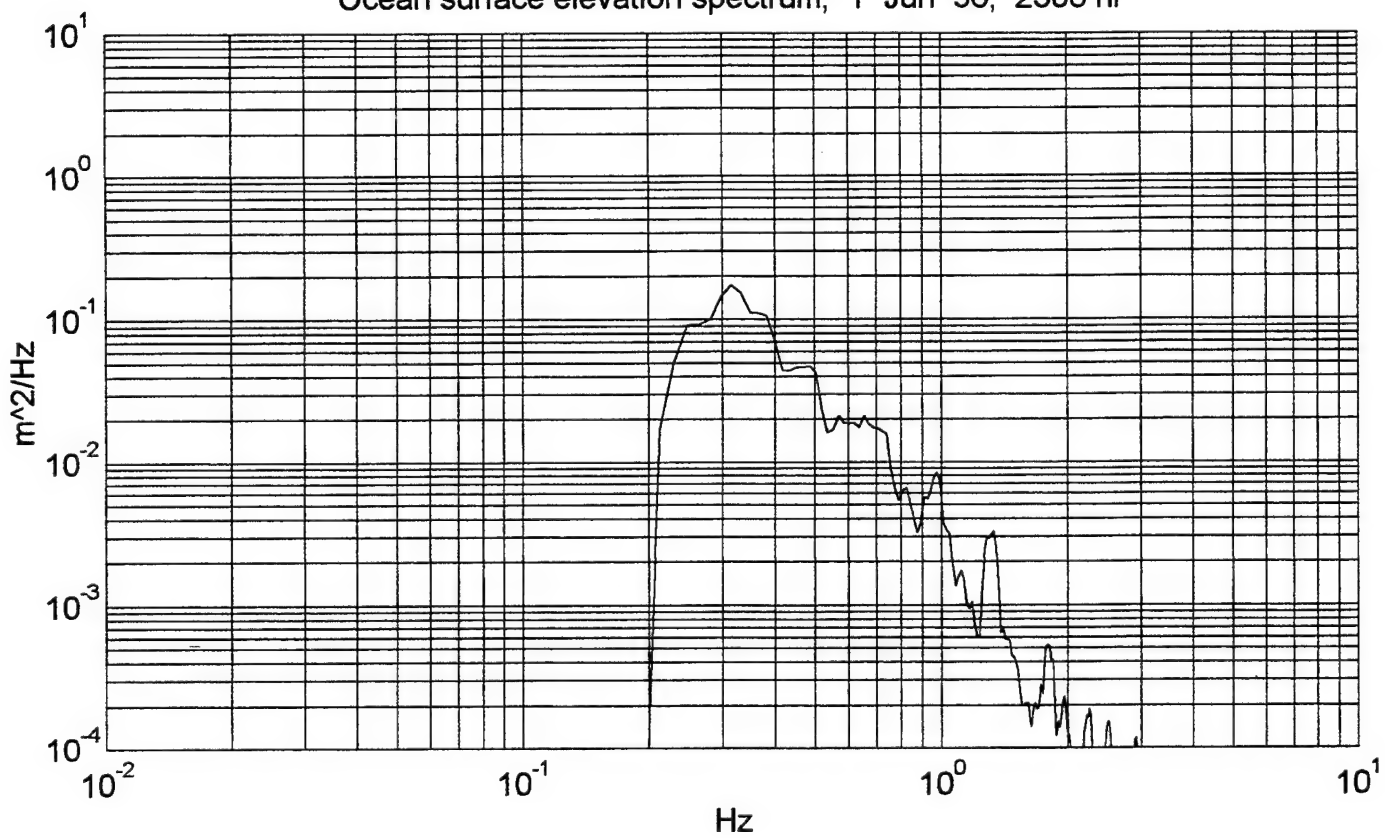
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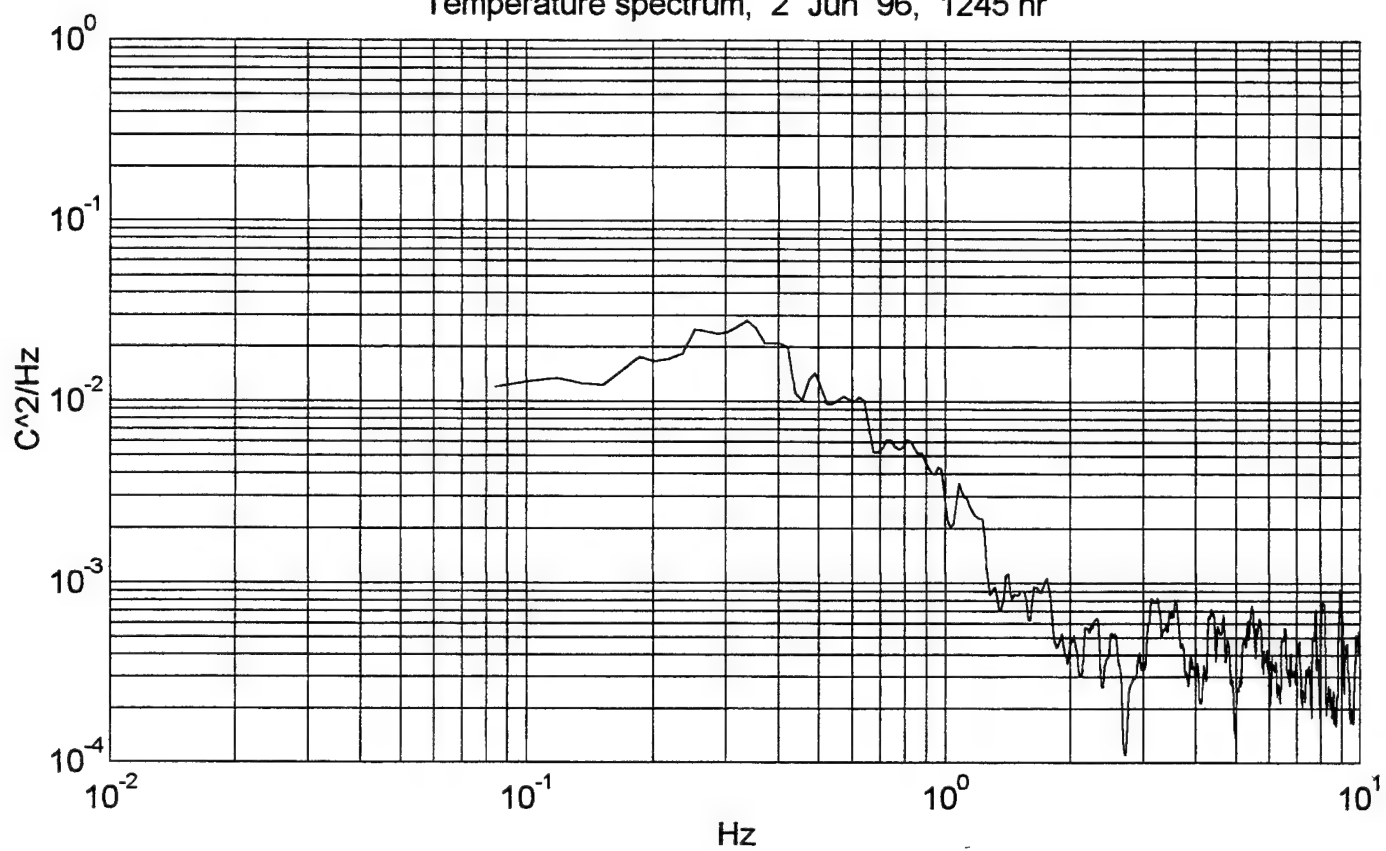
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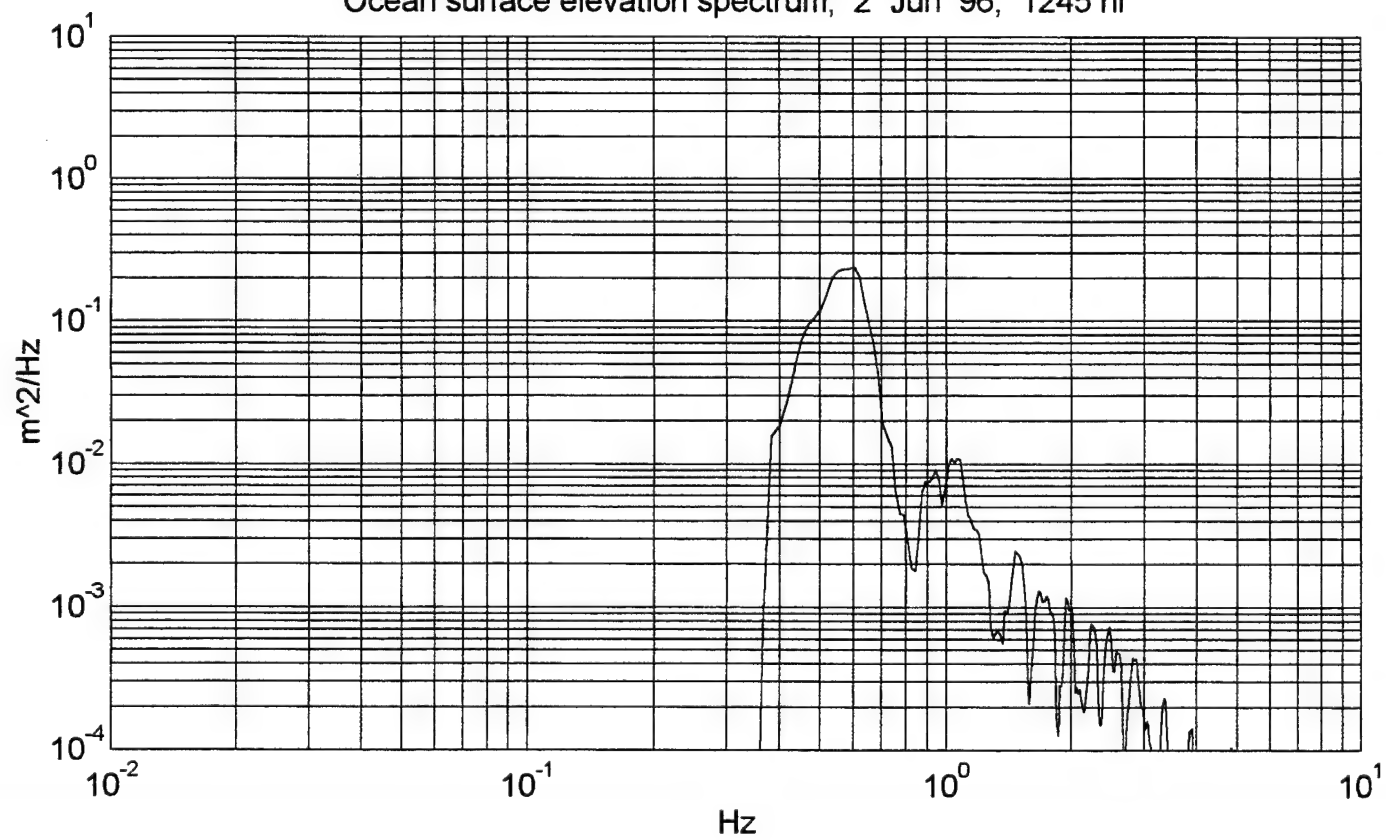
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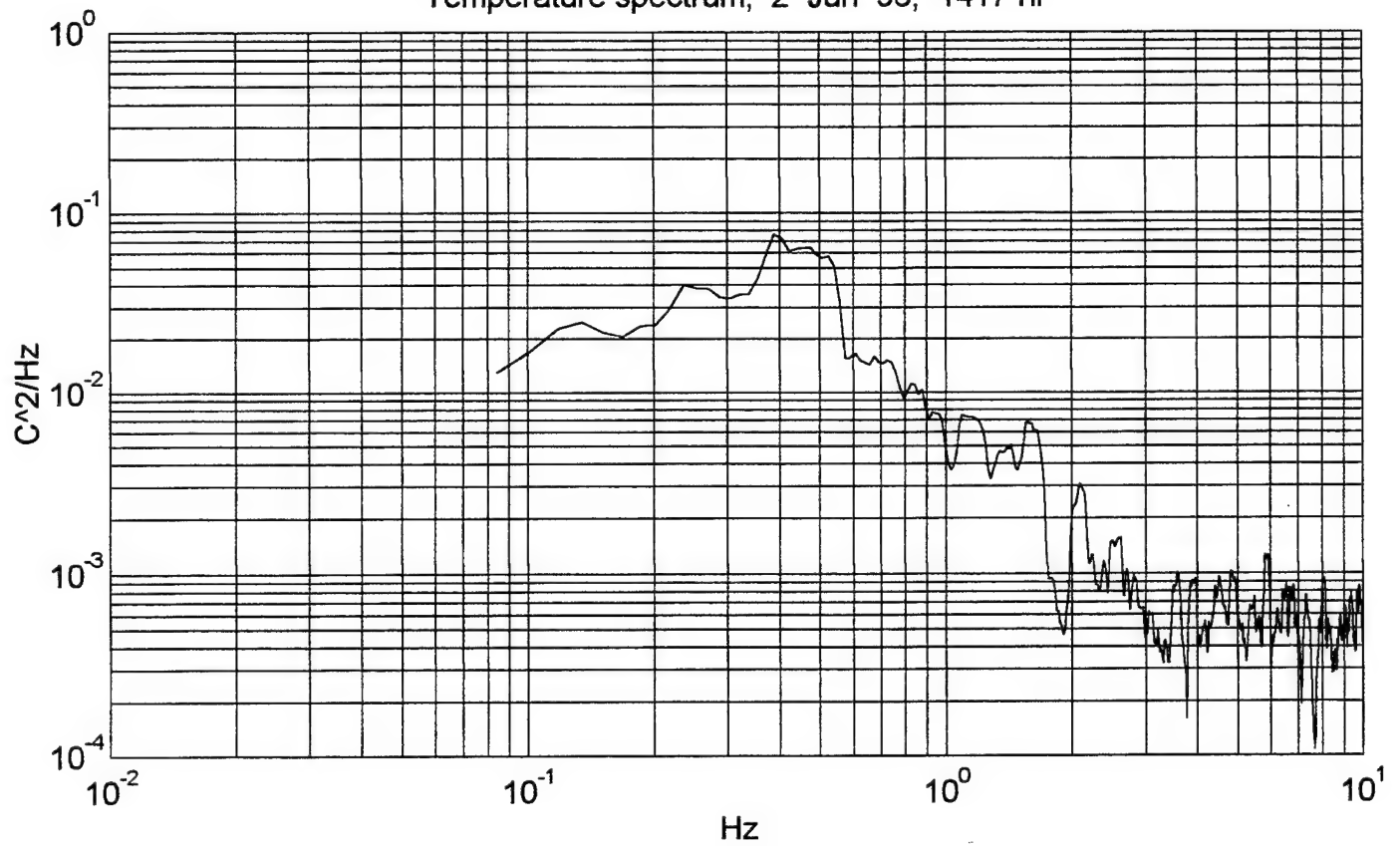
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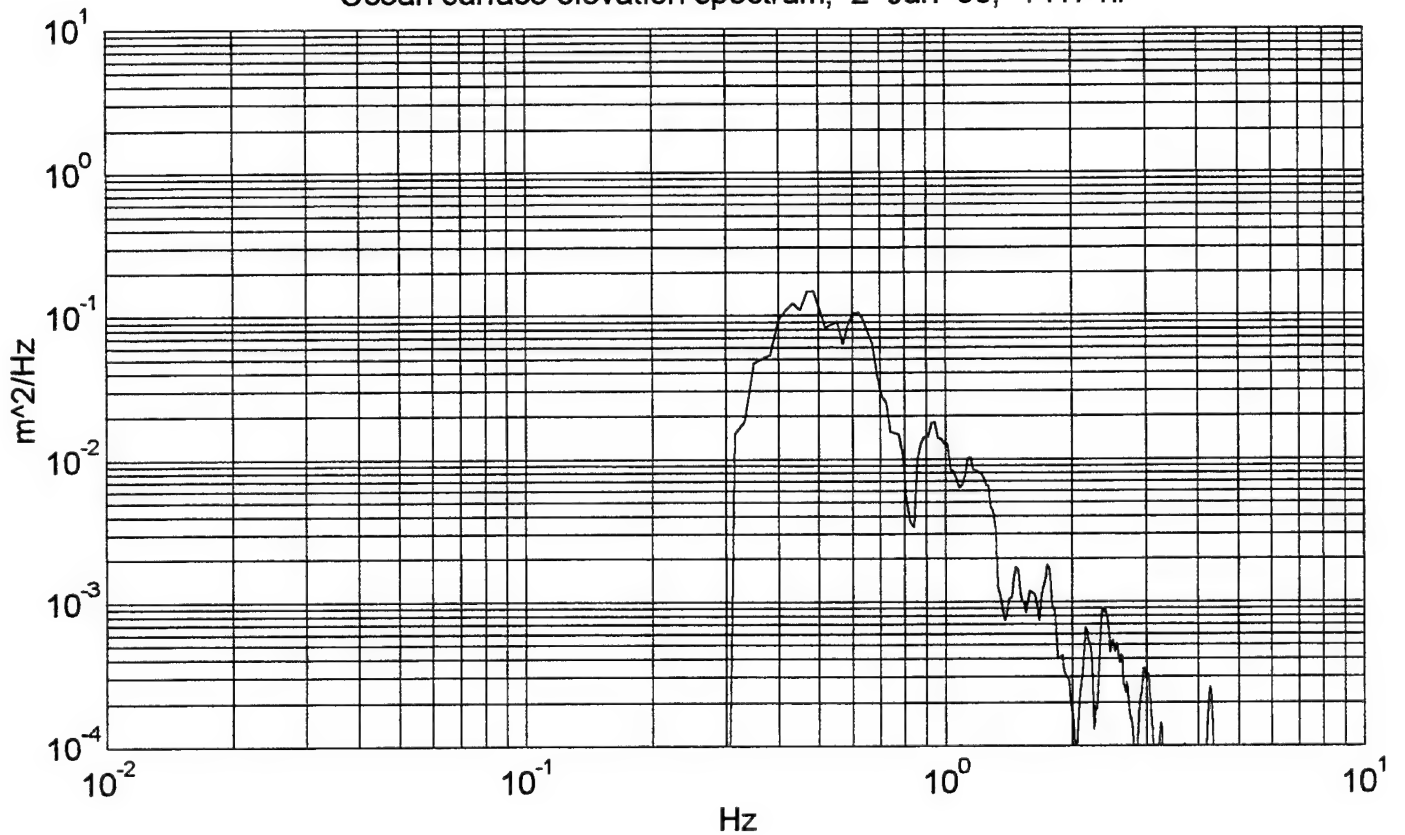
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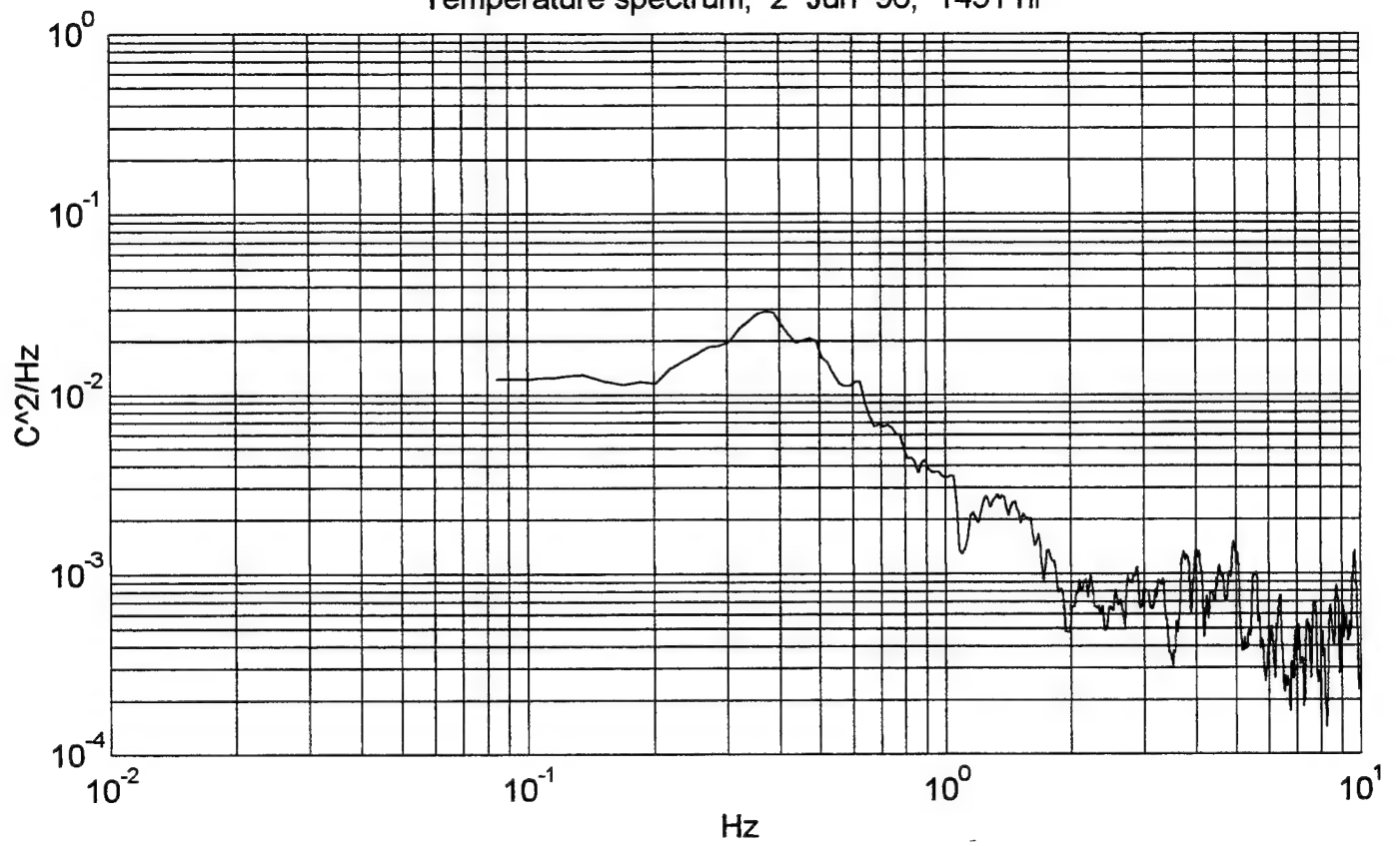
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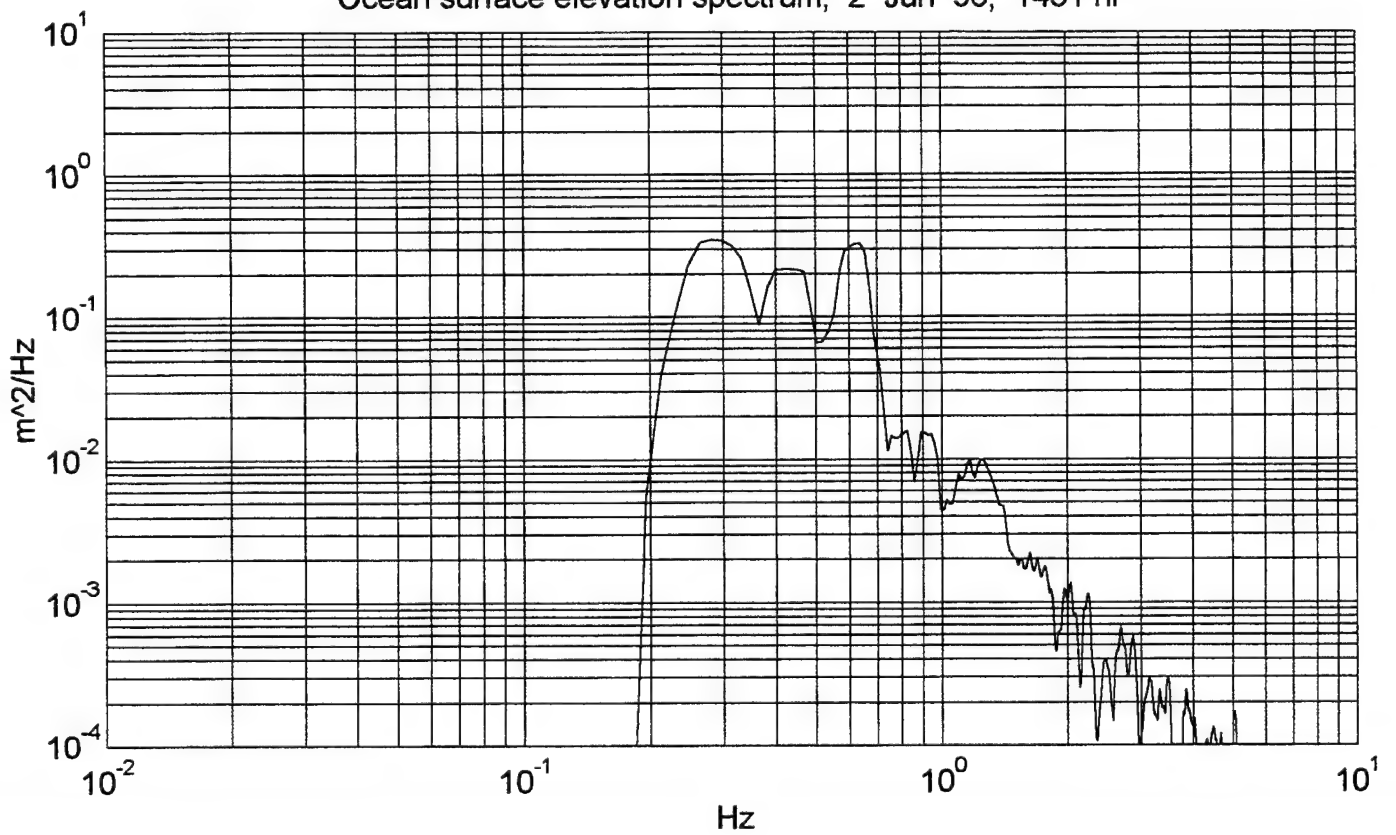
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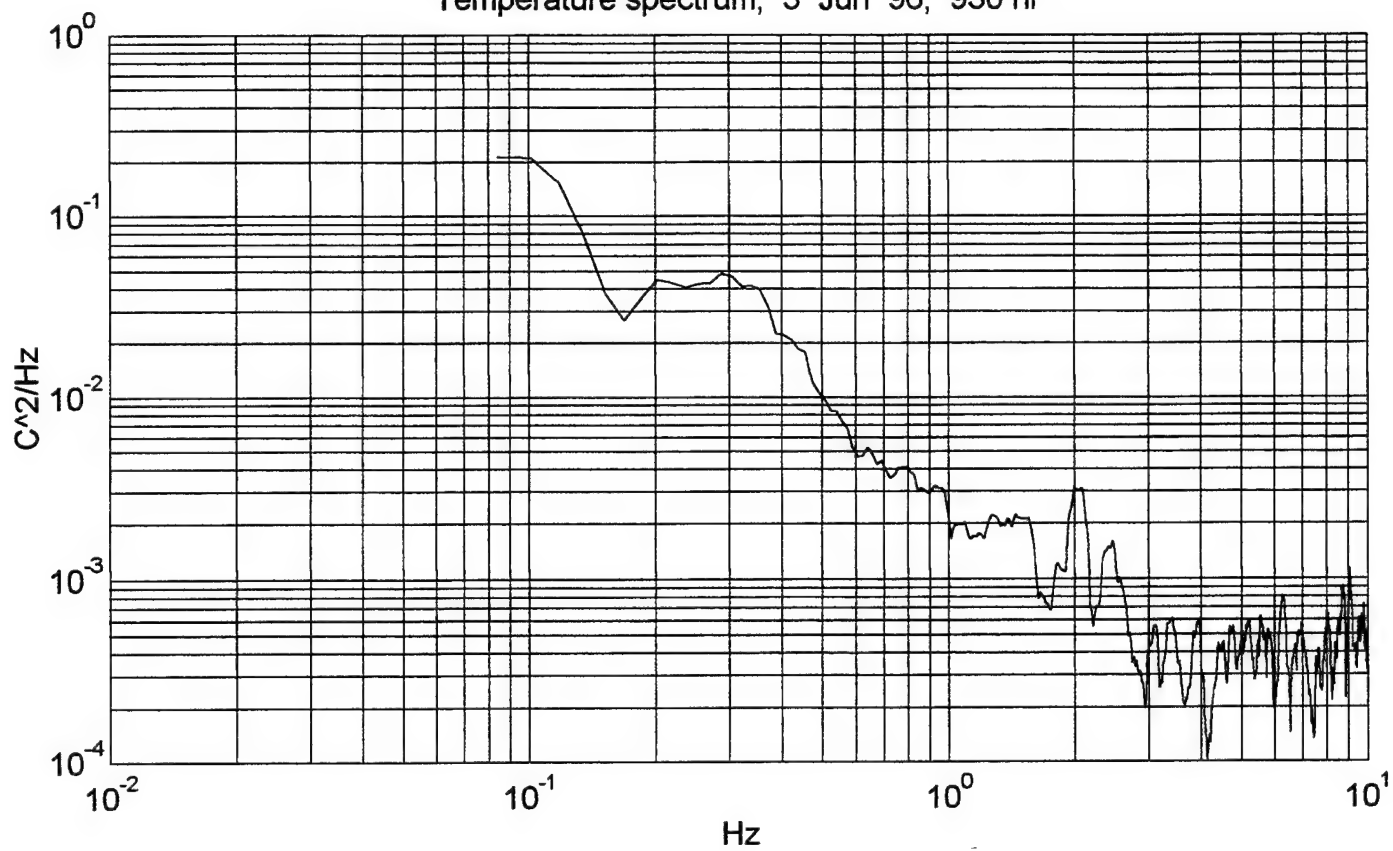
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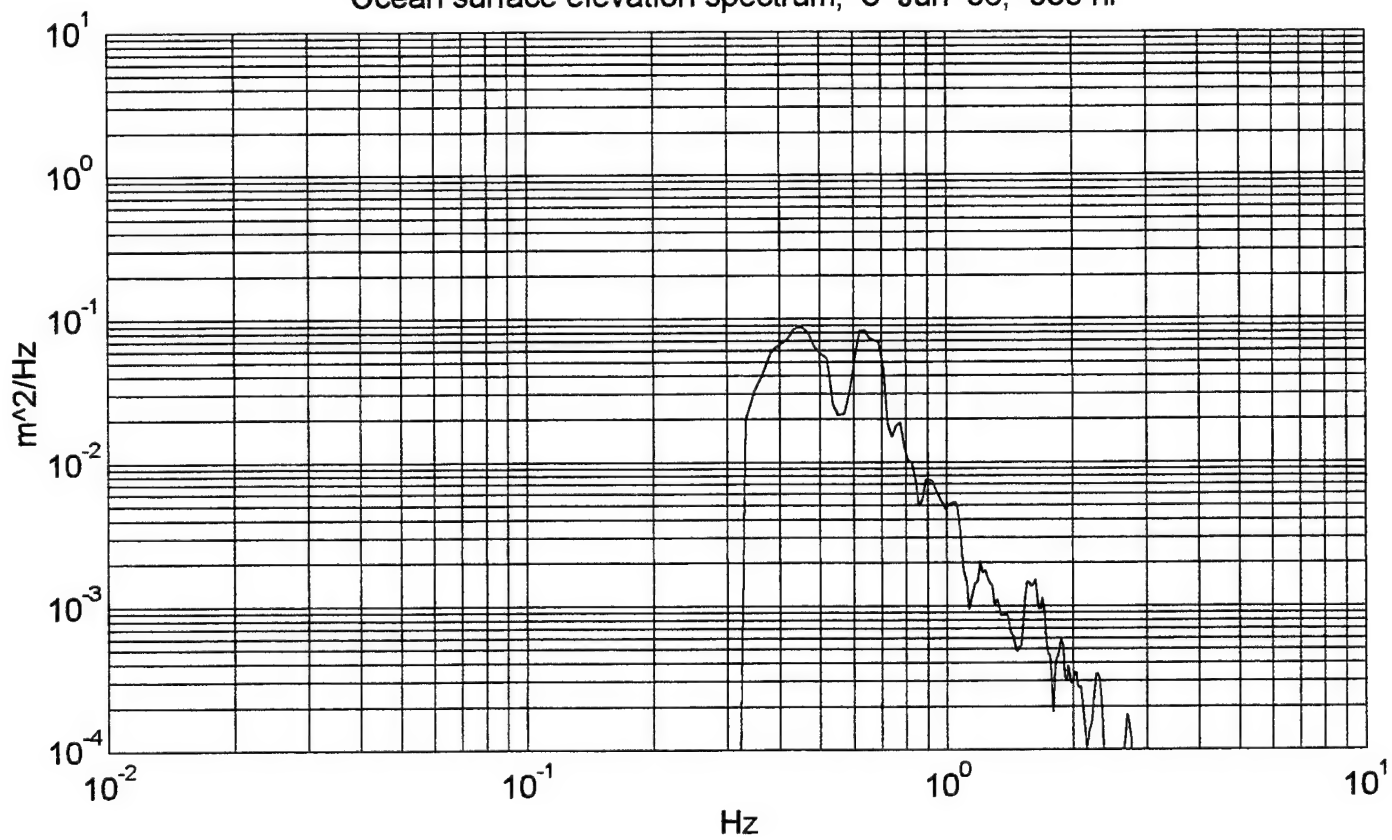
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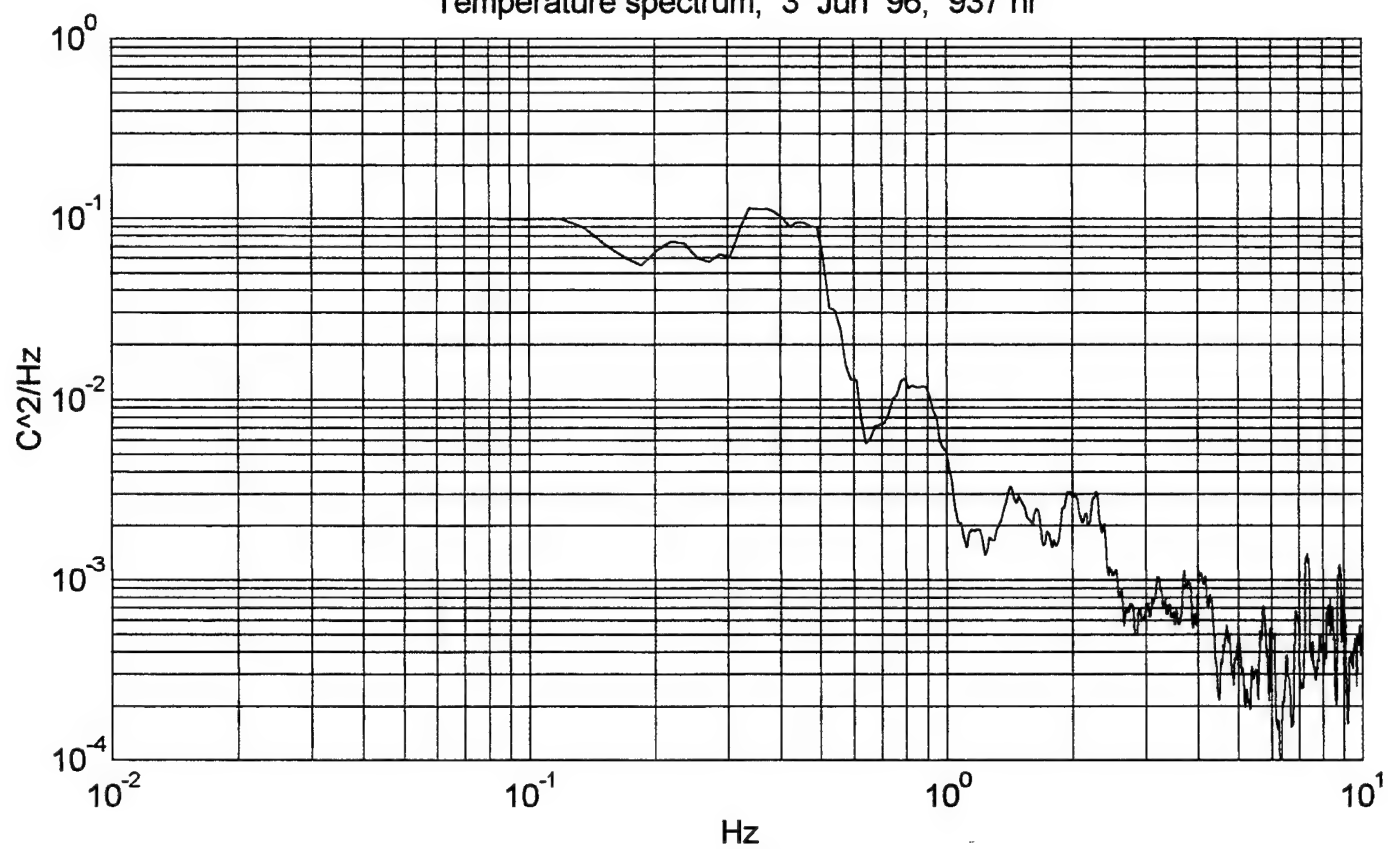
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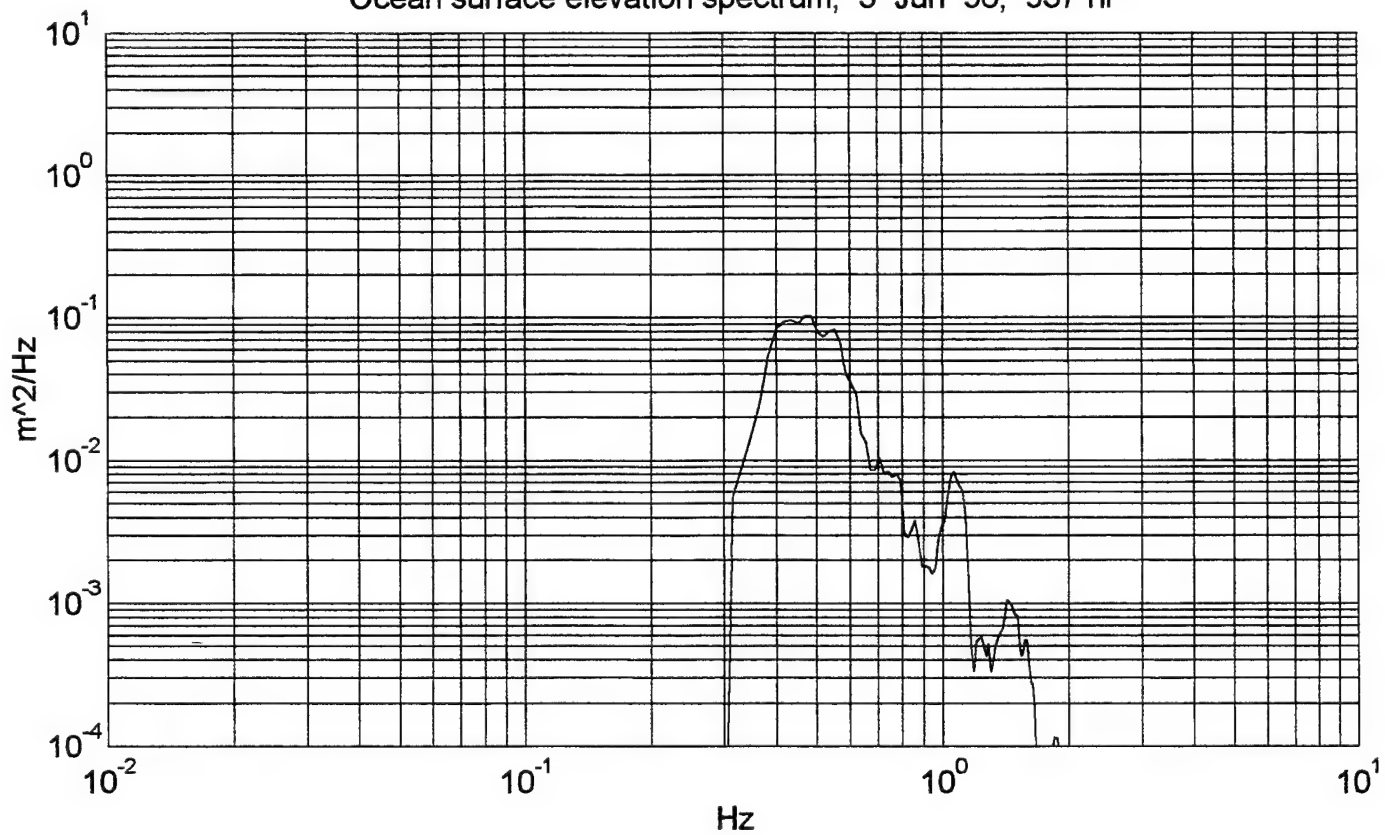
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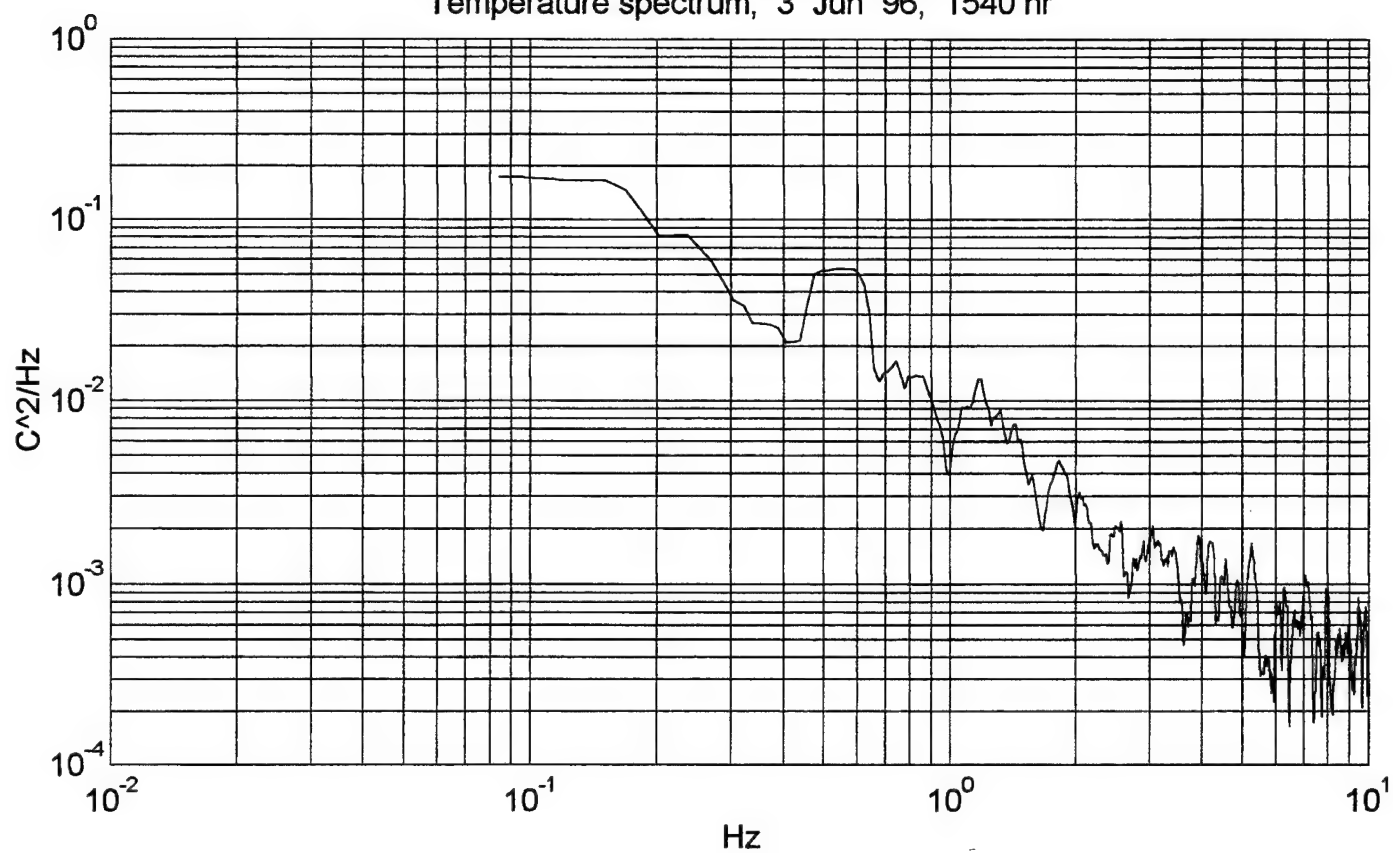
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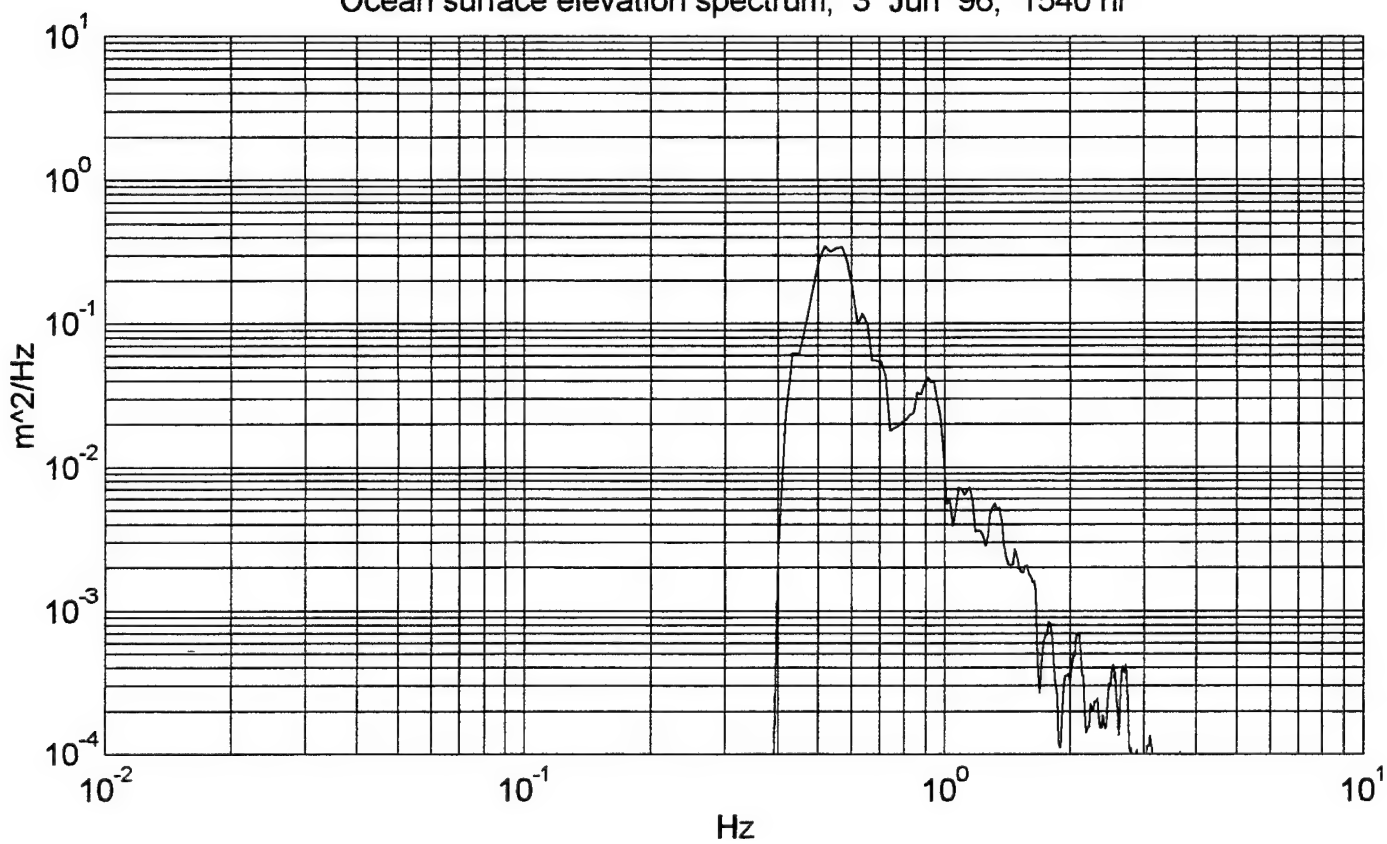
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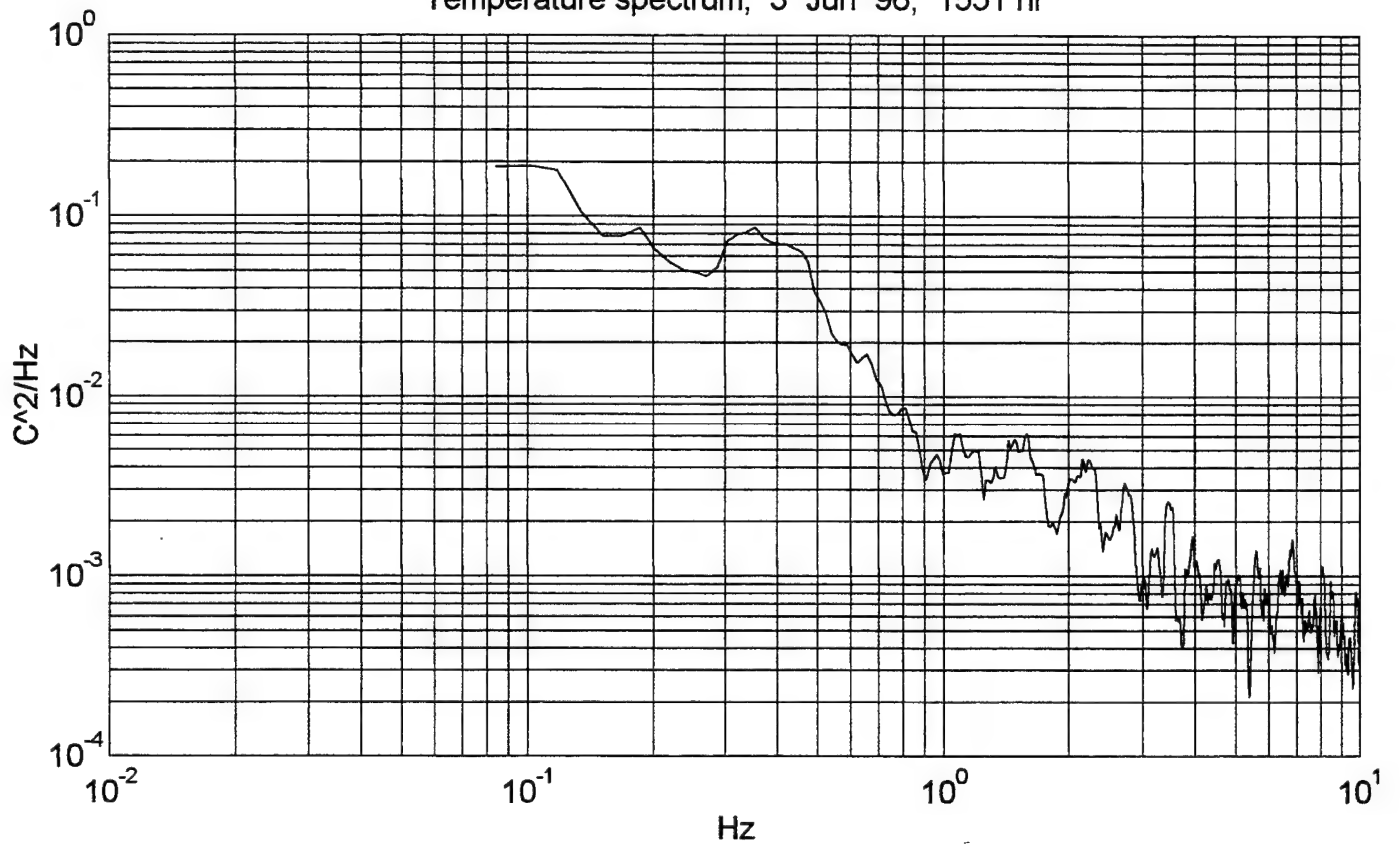
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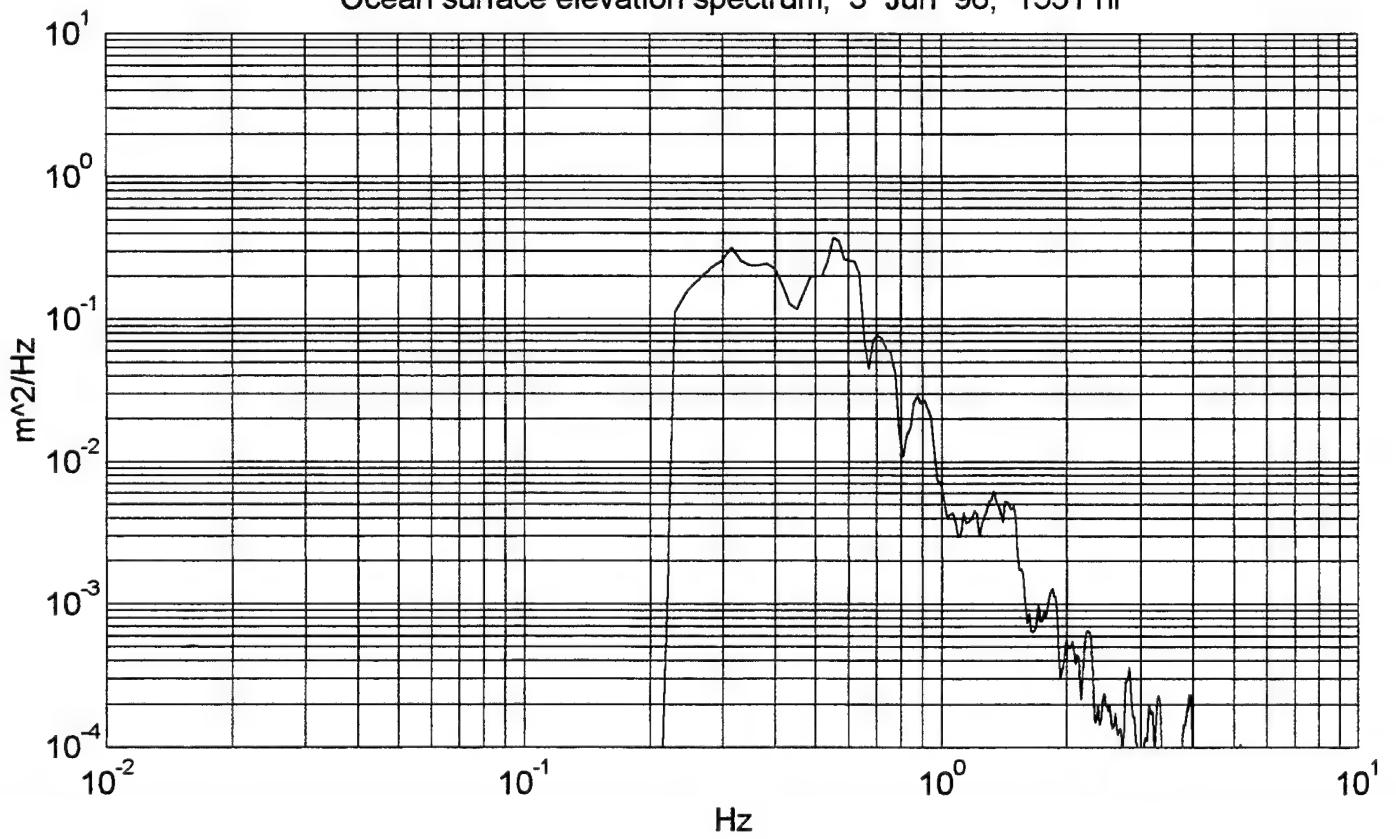
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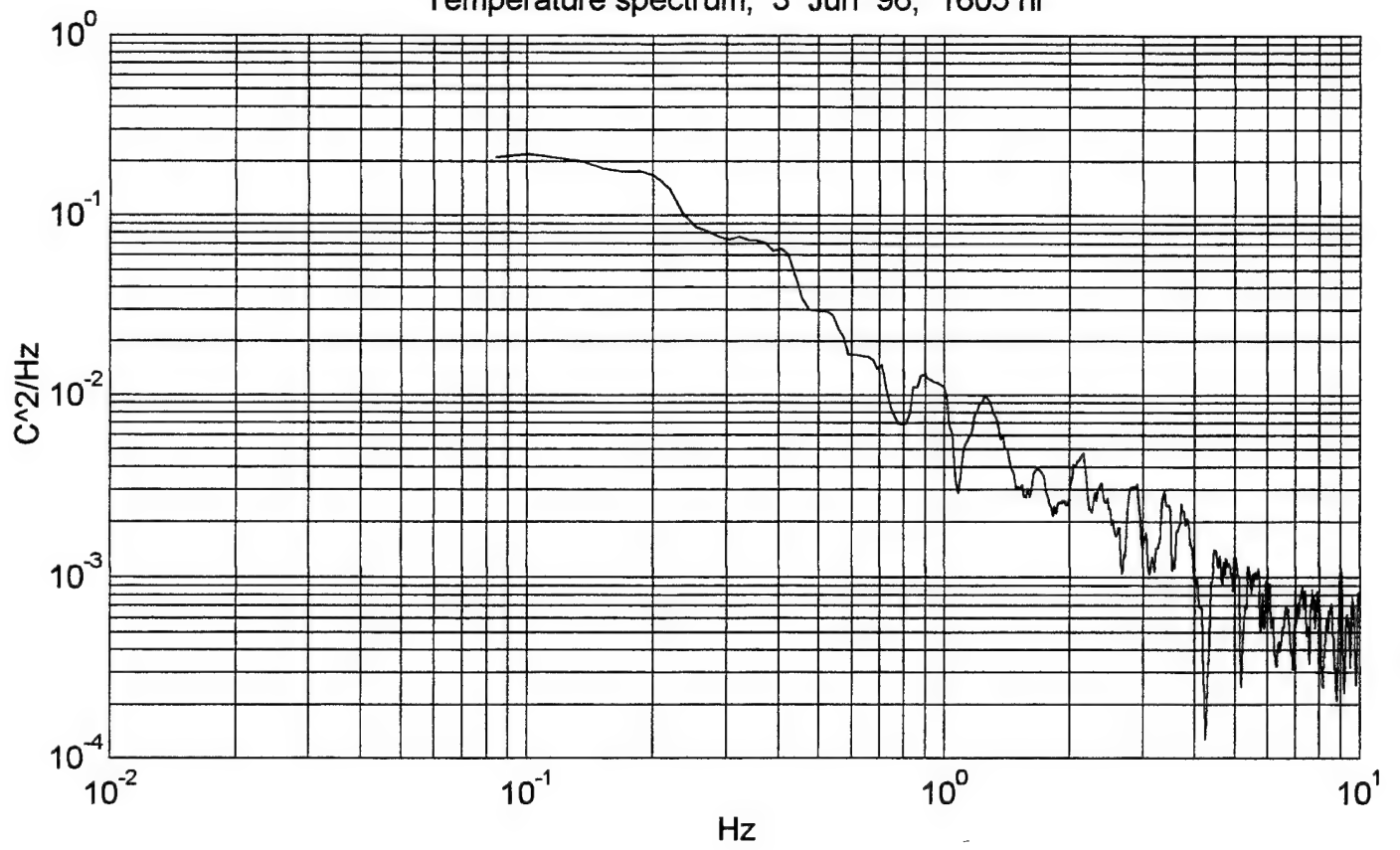
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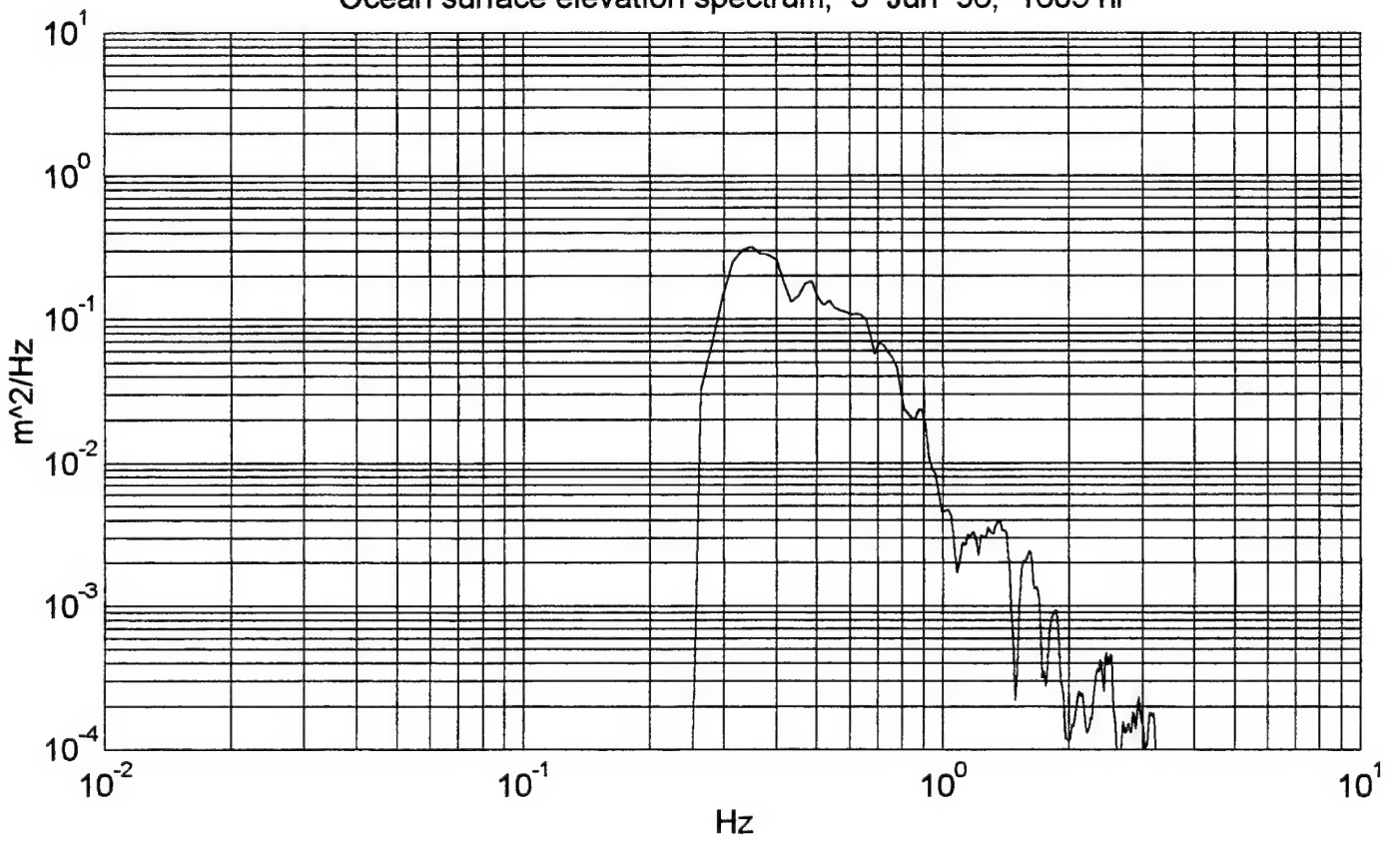
Ocean surface elevation spectrum, 3 Jun 96, 1551 hr



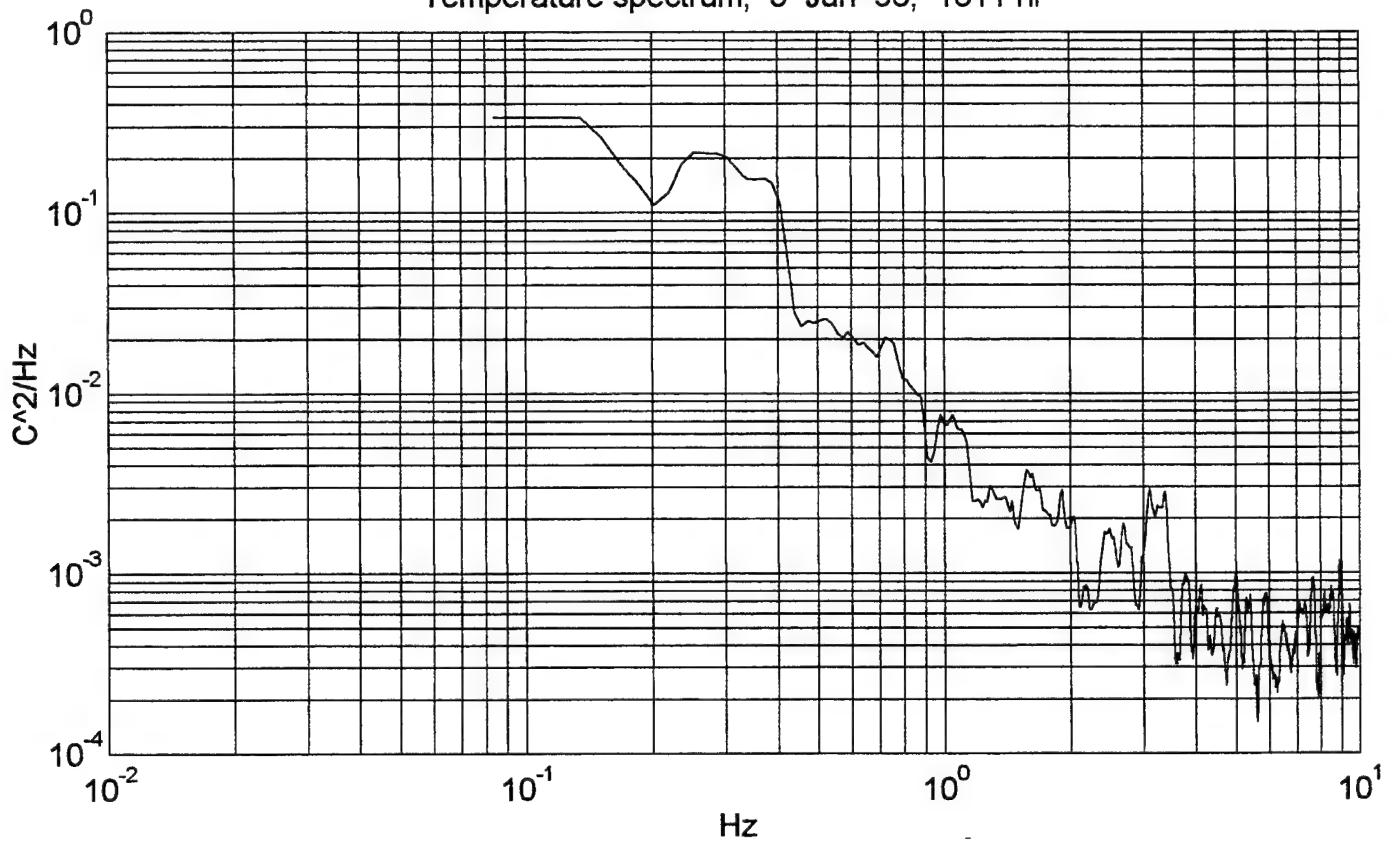
Temperature spectrum, 3 Jun 96, 1605 hr



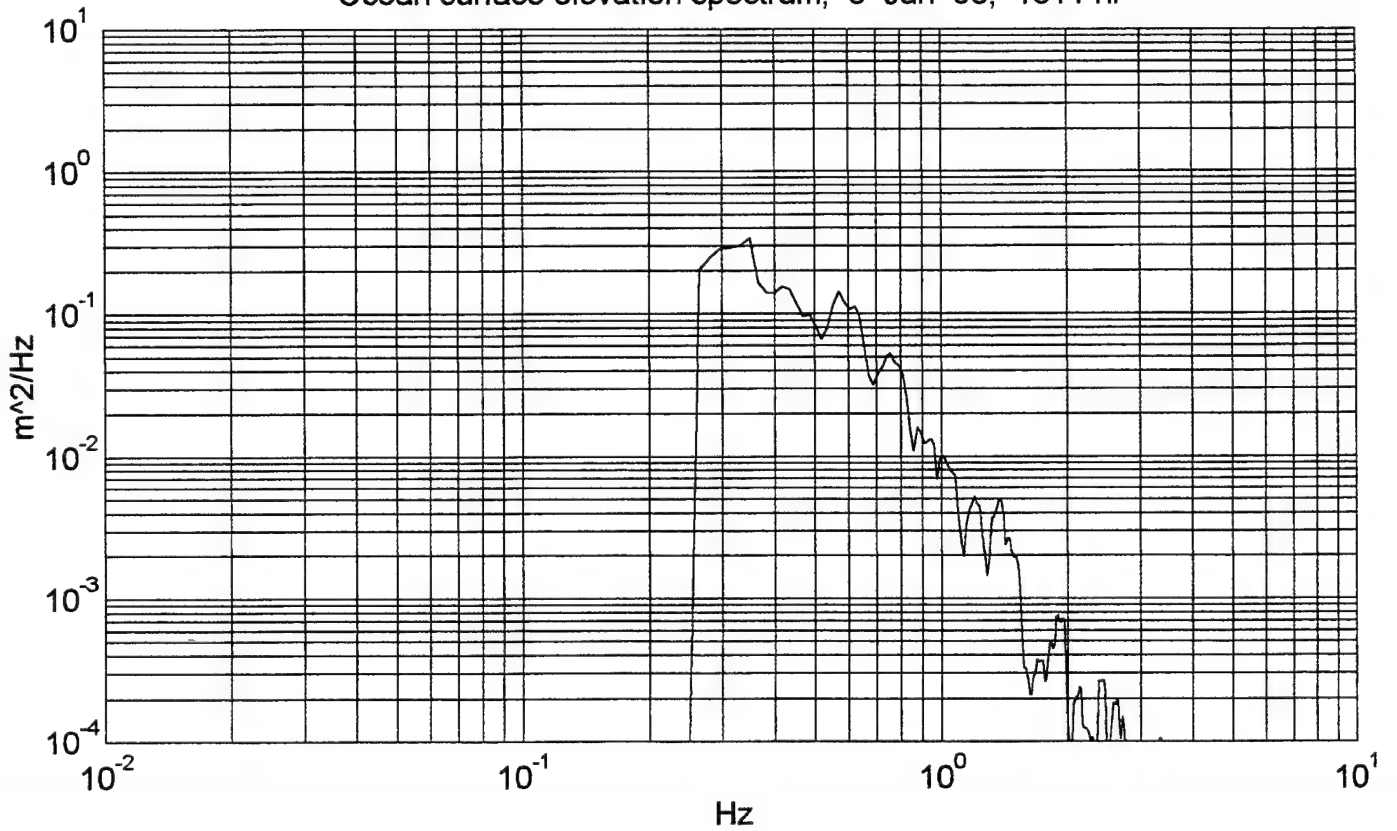
Ocean surface elevation spectrum, 3 Jun 96, 1605 hr



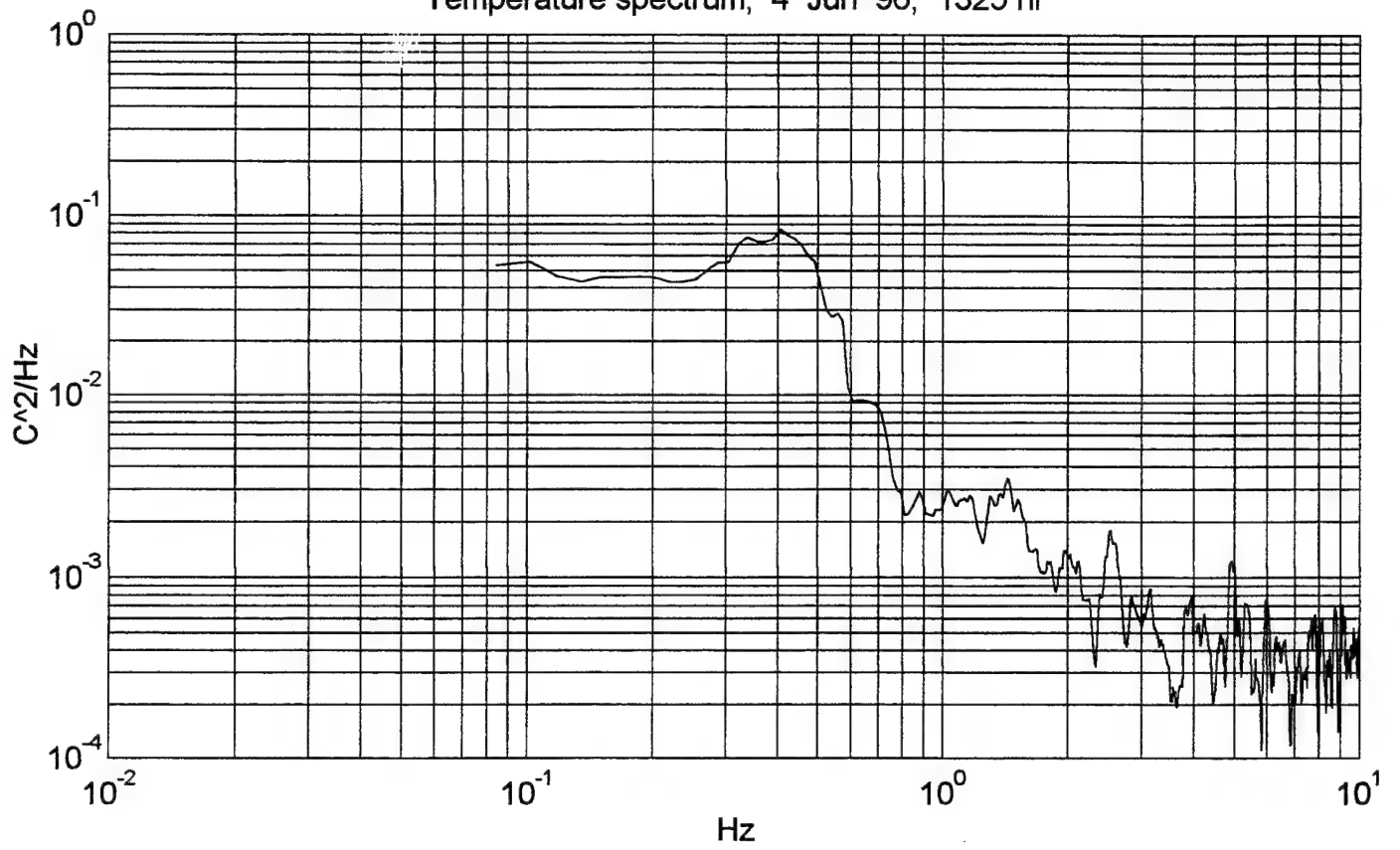
Temperature spectrum, 3 Jun 96, 1611 hr



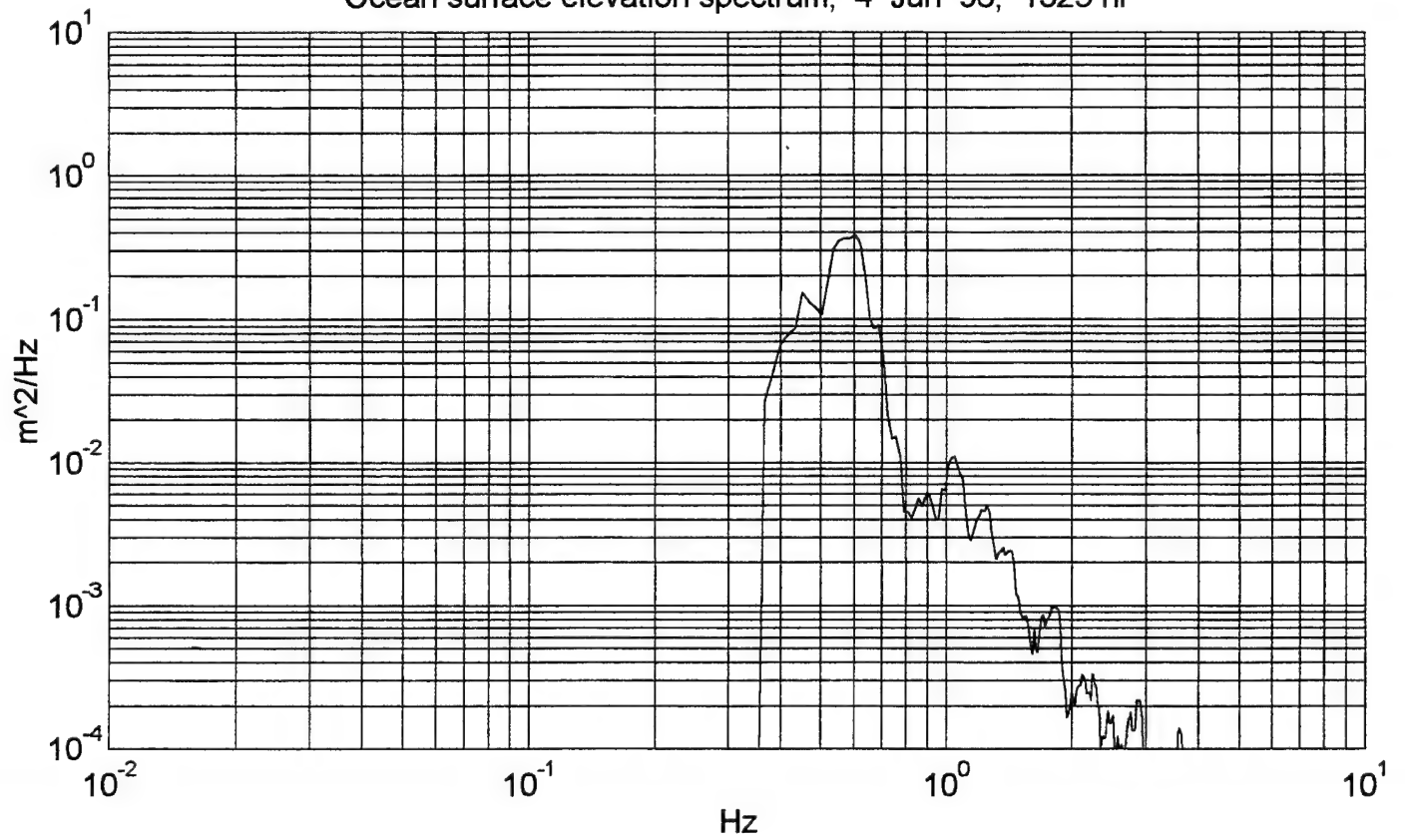
Ocean surface elevation spectrum, 3 Jun 96, 1611 hr



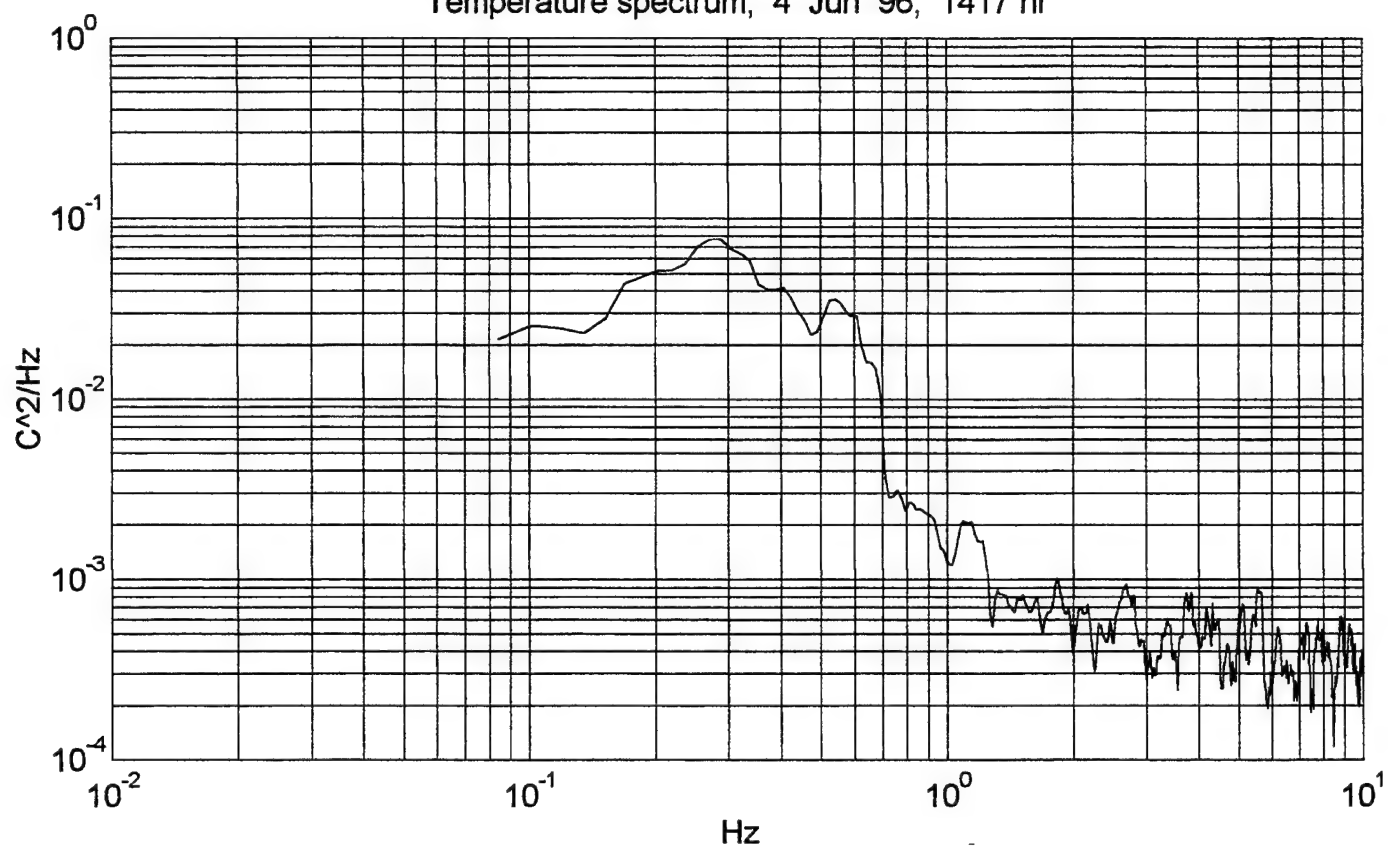
Temperature spectrum, 4 Jun 96, 1325 hr



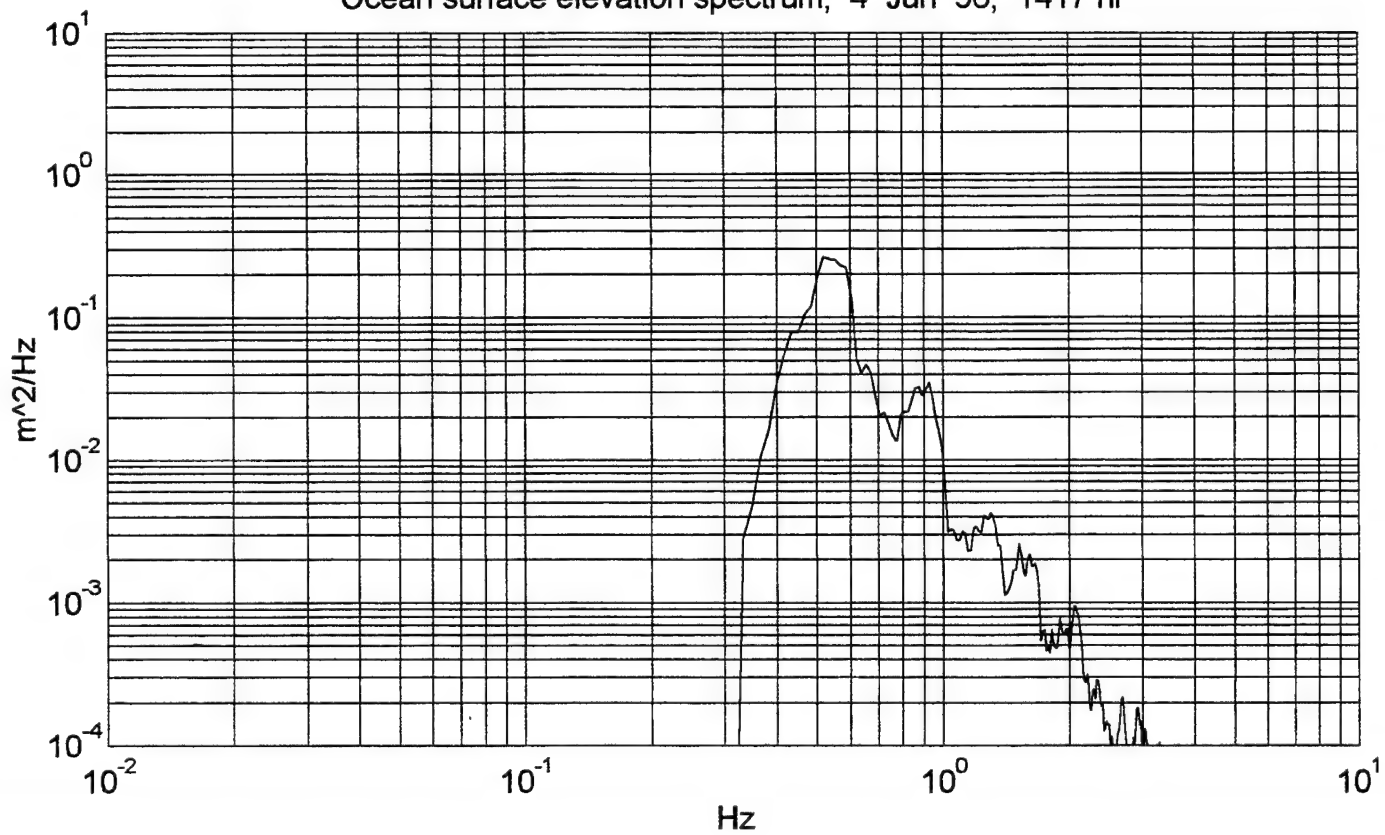
Ocean surface elevation spectrum, 4 Jun 96, 1325 hr



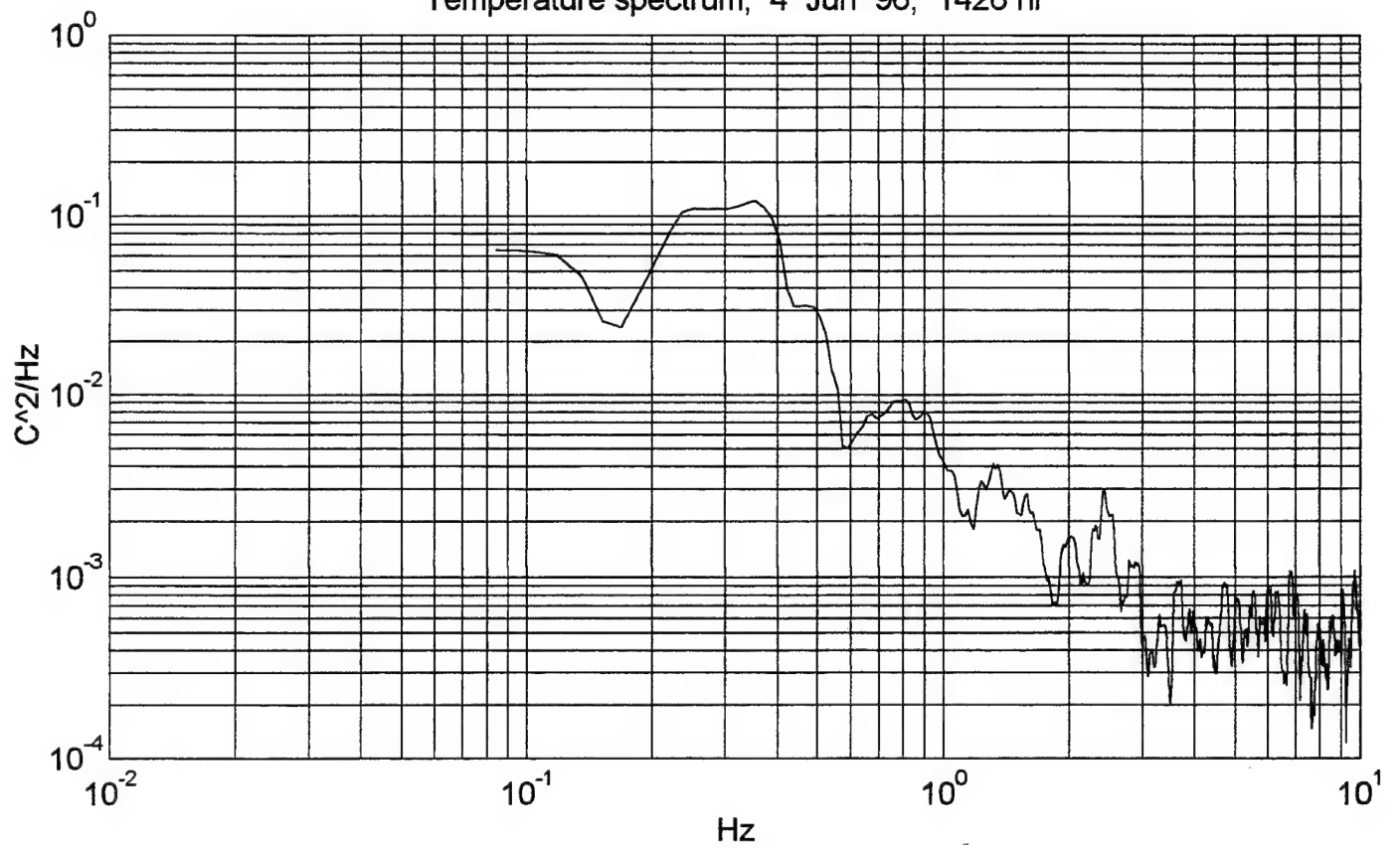
Temperature spectrum, 4 Jun 96, 1417 hr



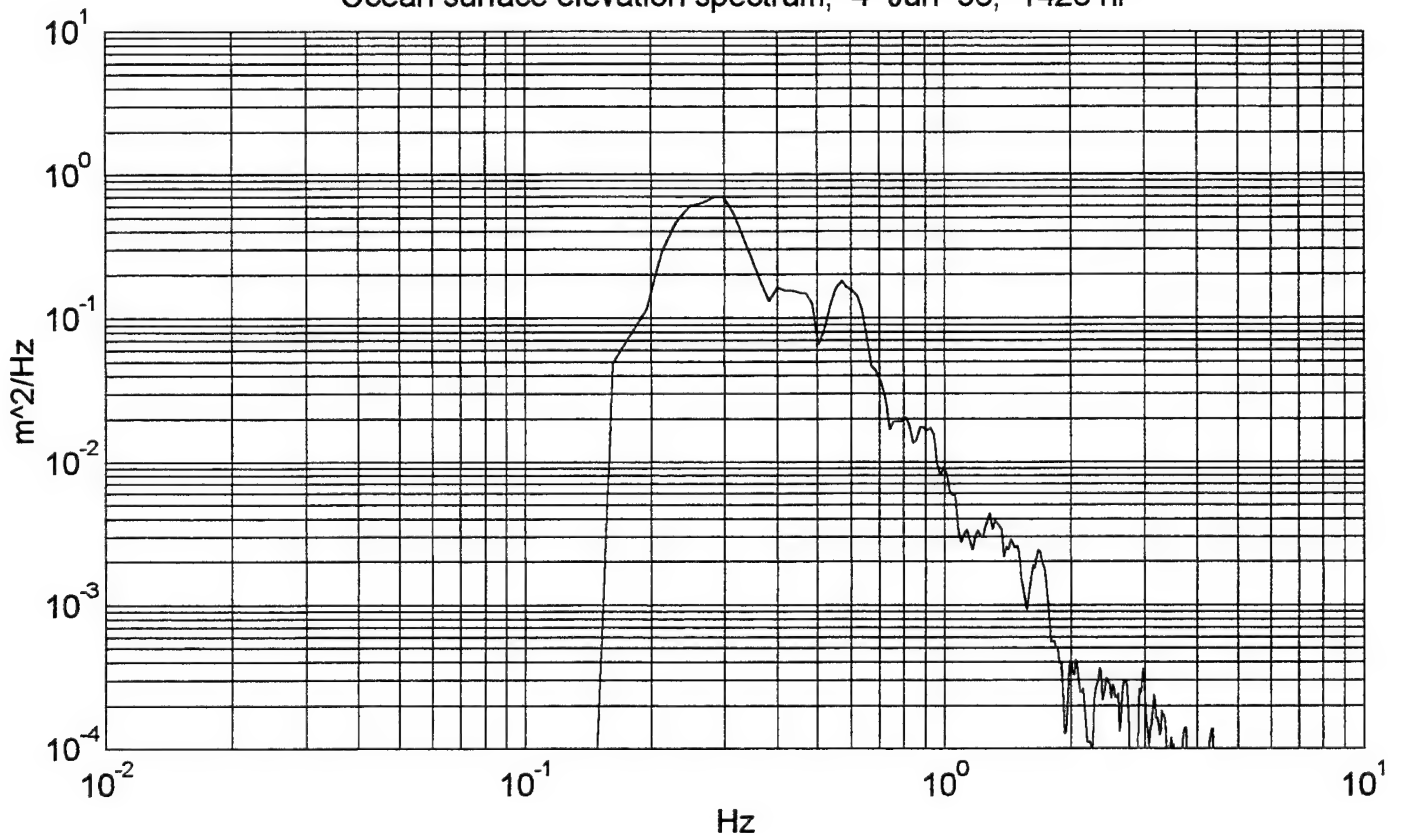
Ocean surface elevation spectrum, 4 Jun 96, 1417 hr



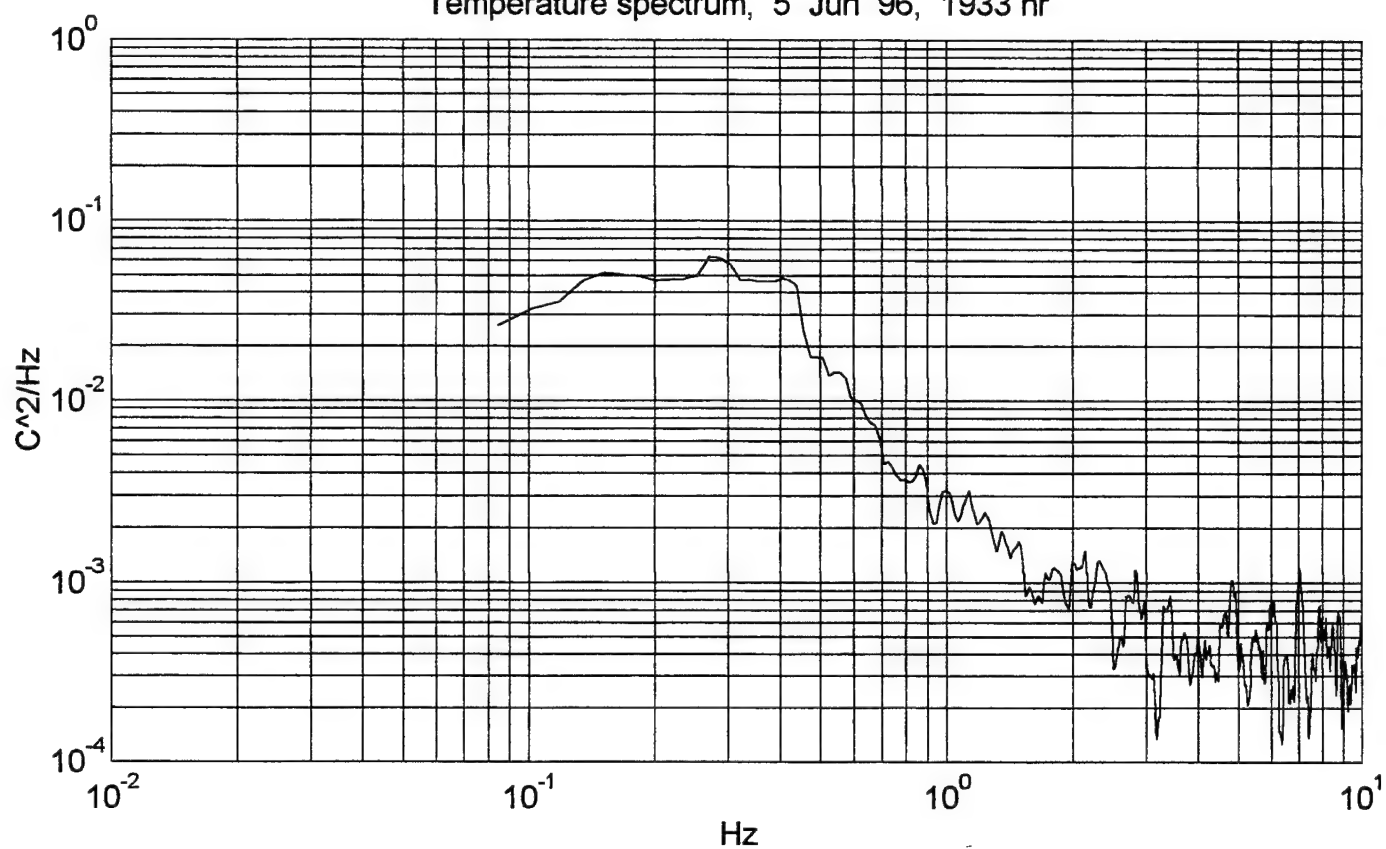
Temperature spectrum, 4 Jun 96, 1426 hr



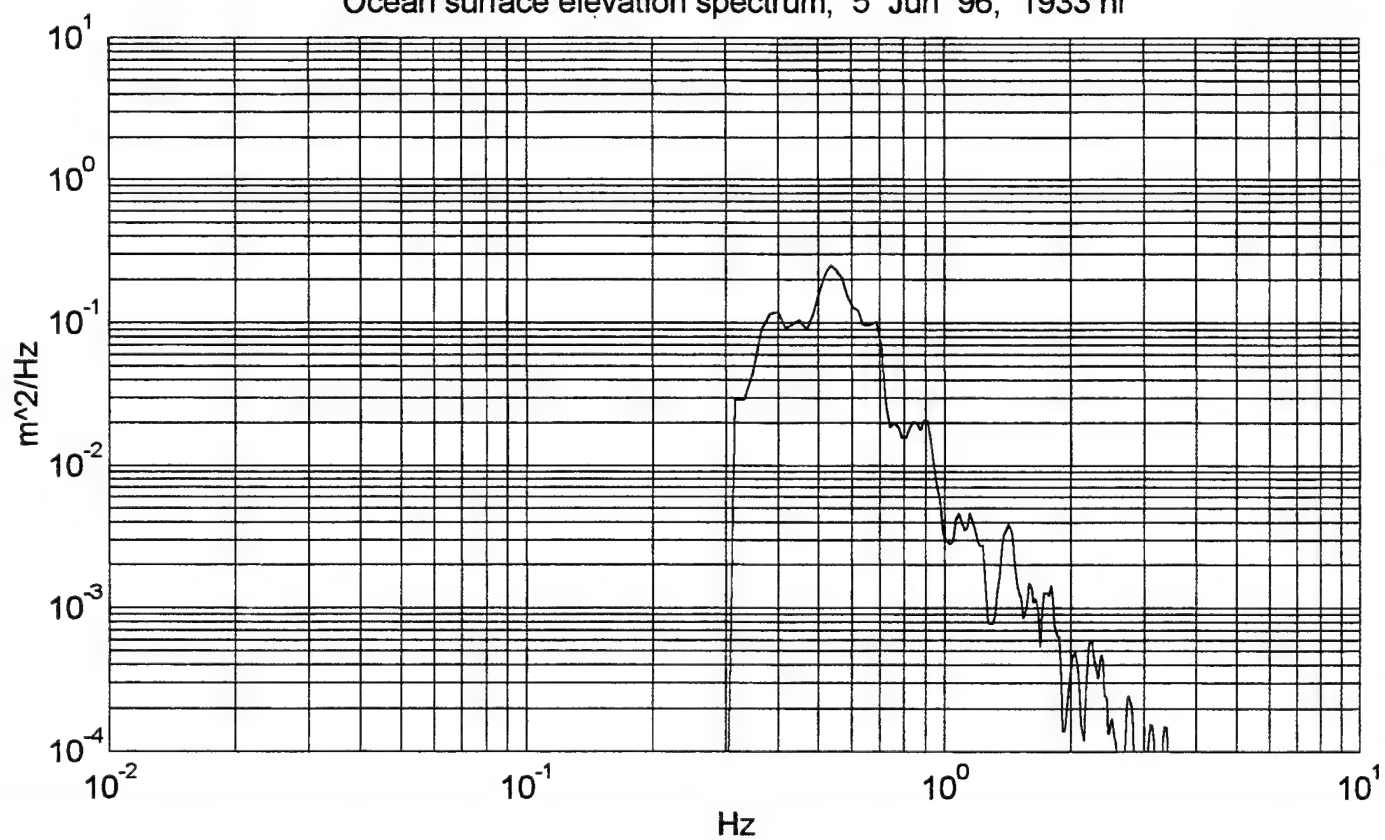
Ocean surface elevation spectrum, 4 Jun 96, 1426 hr



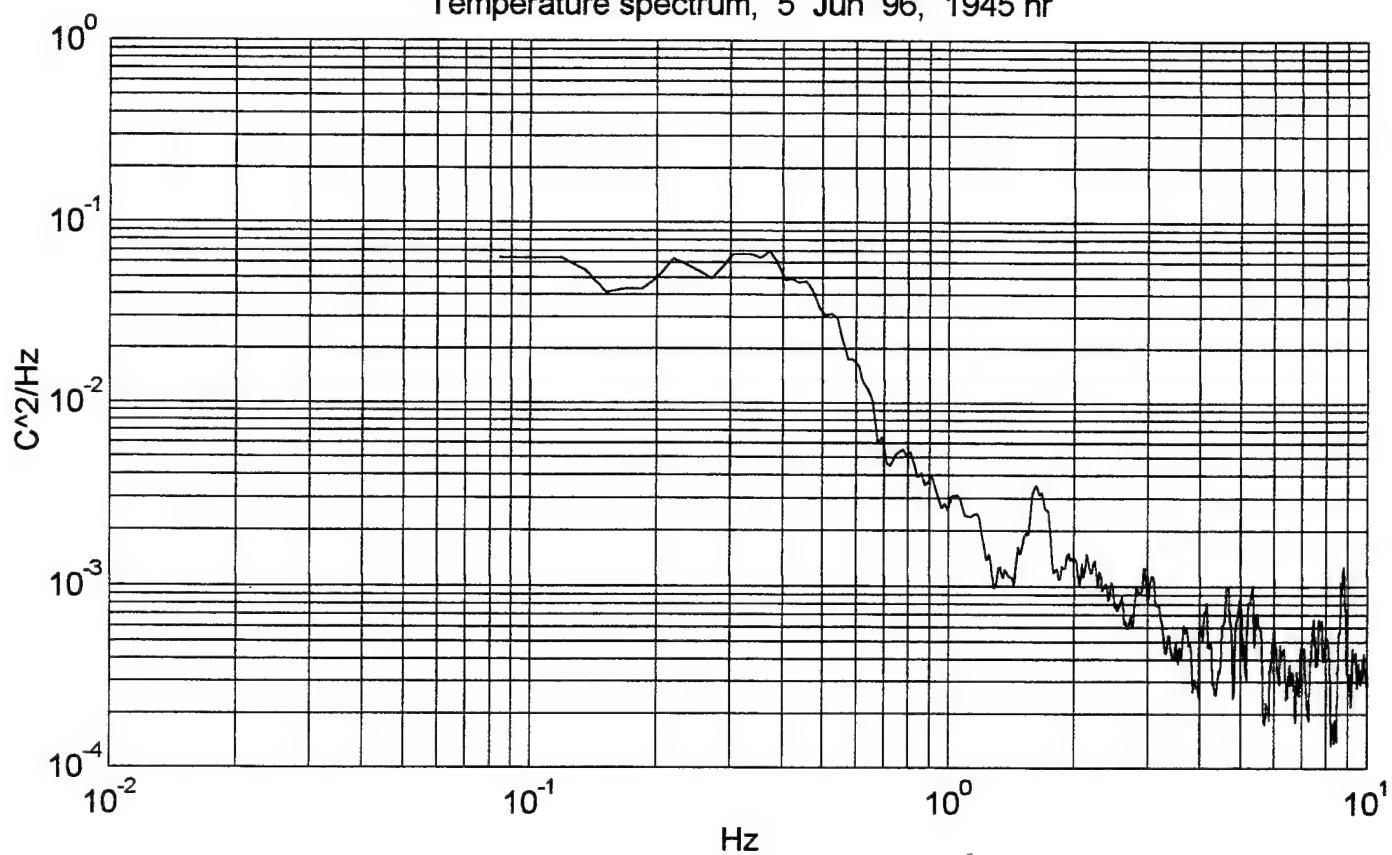
Temperature spectrum, 5 Jun 96, 1933 hr



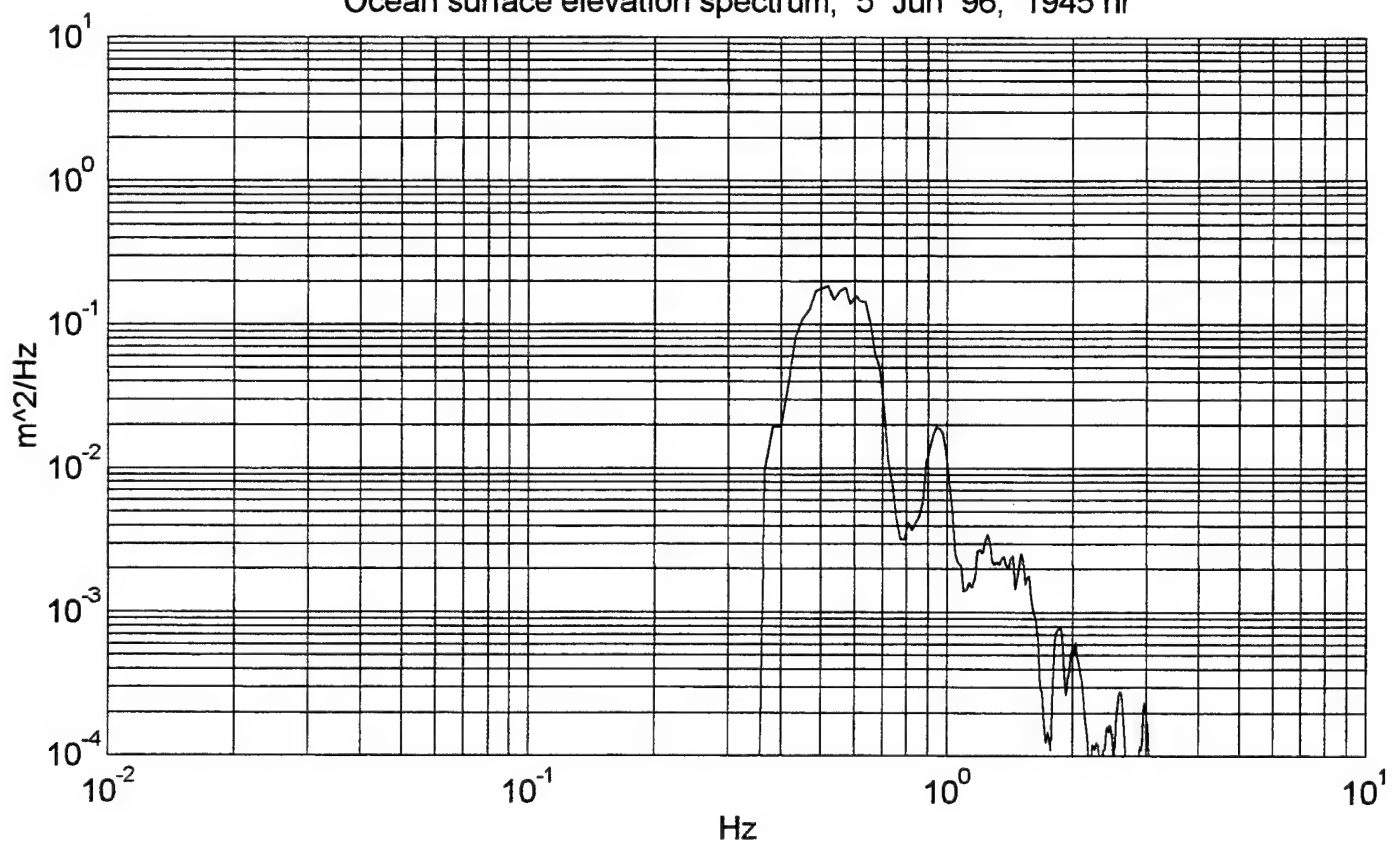
Ocean surface elevation spectrum, 5 Jun 96, 1933 hr



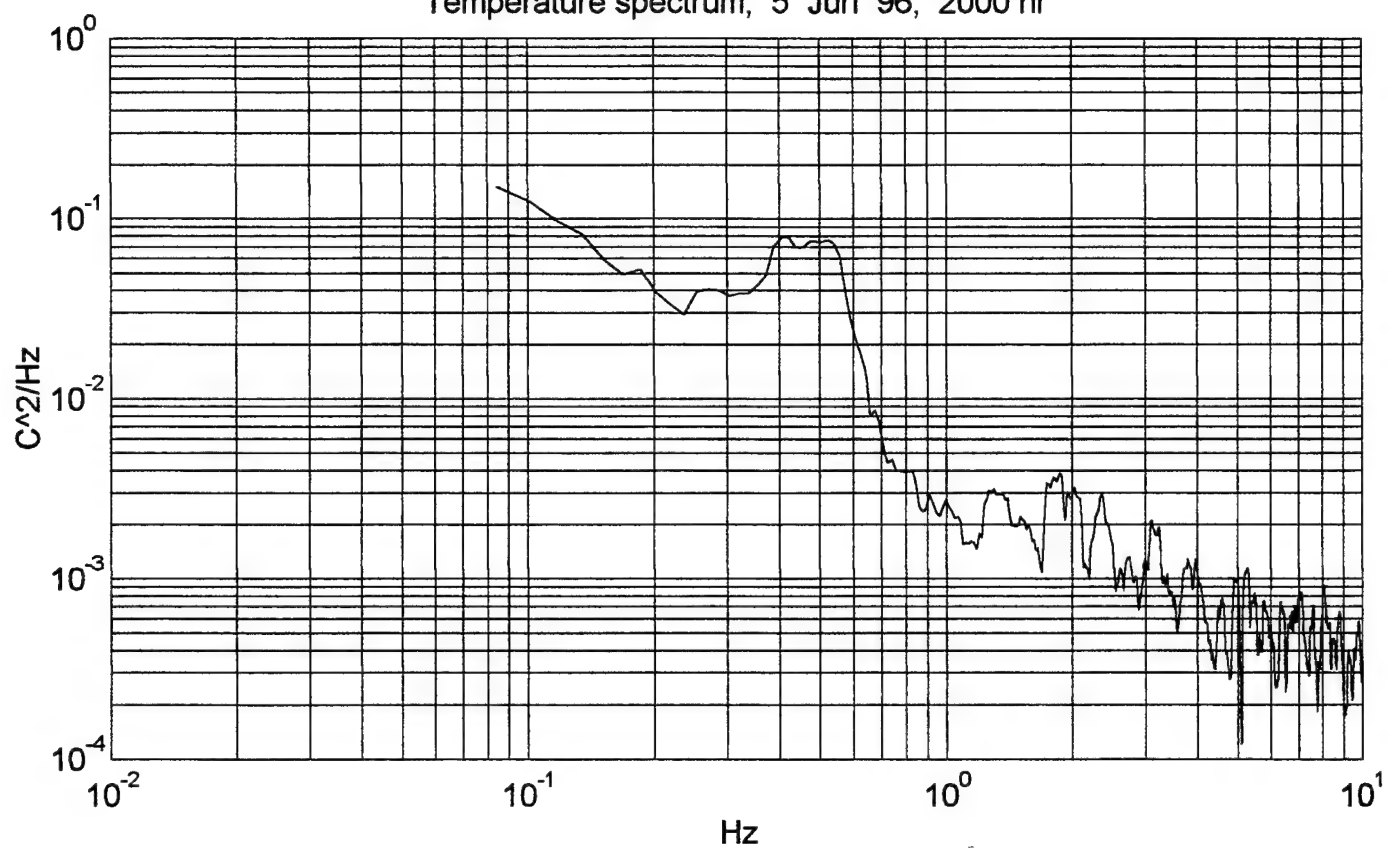
Temperature spectrum, 5 Jun 96, 1945 hr



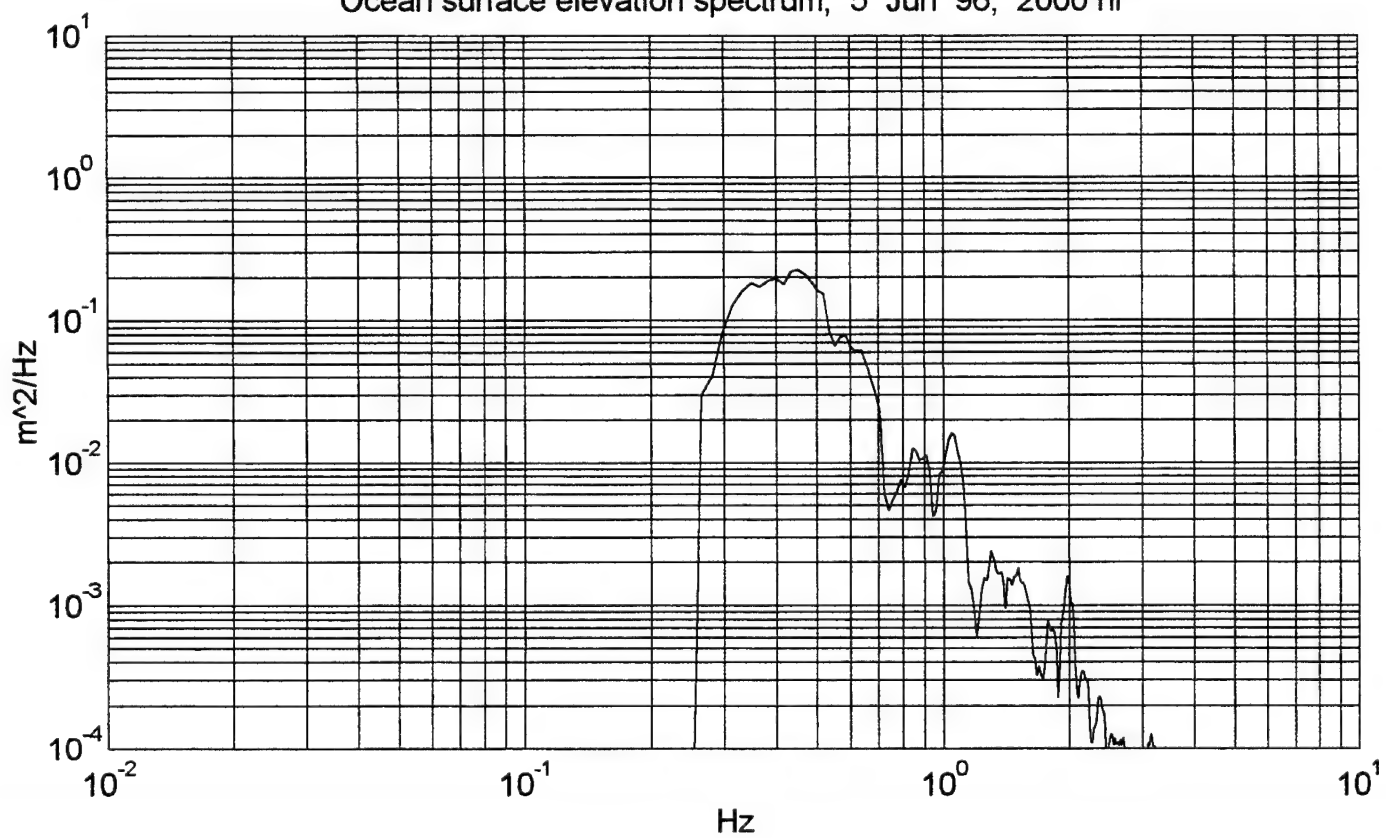
Ocean surface elevation spectrum, 5 Jun 96, 1945 hr



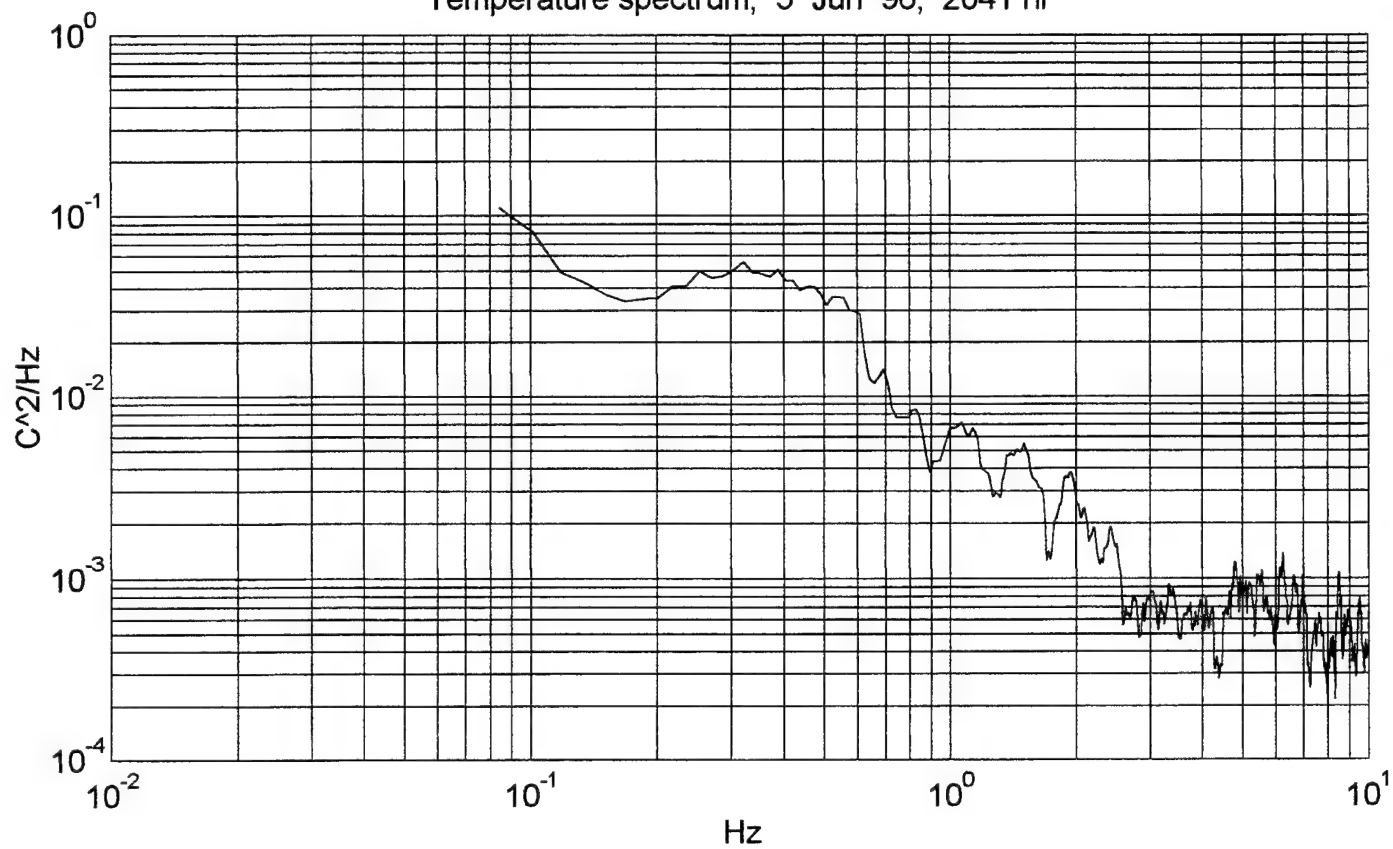
Temperature spectrum, 5 Jun 96, 2000 hr



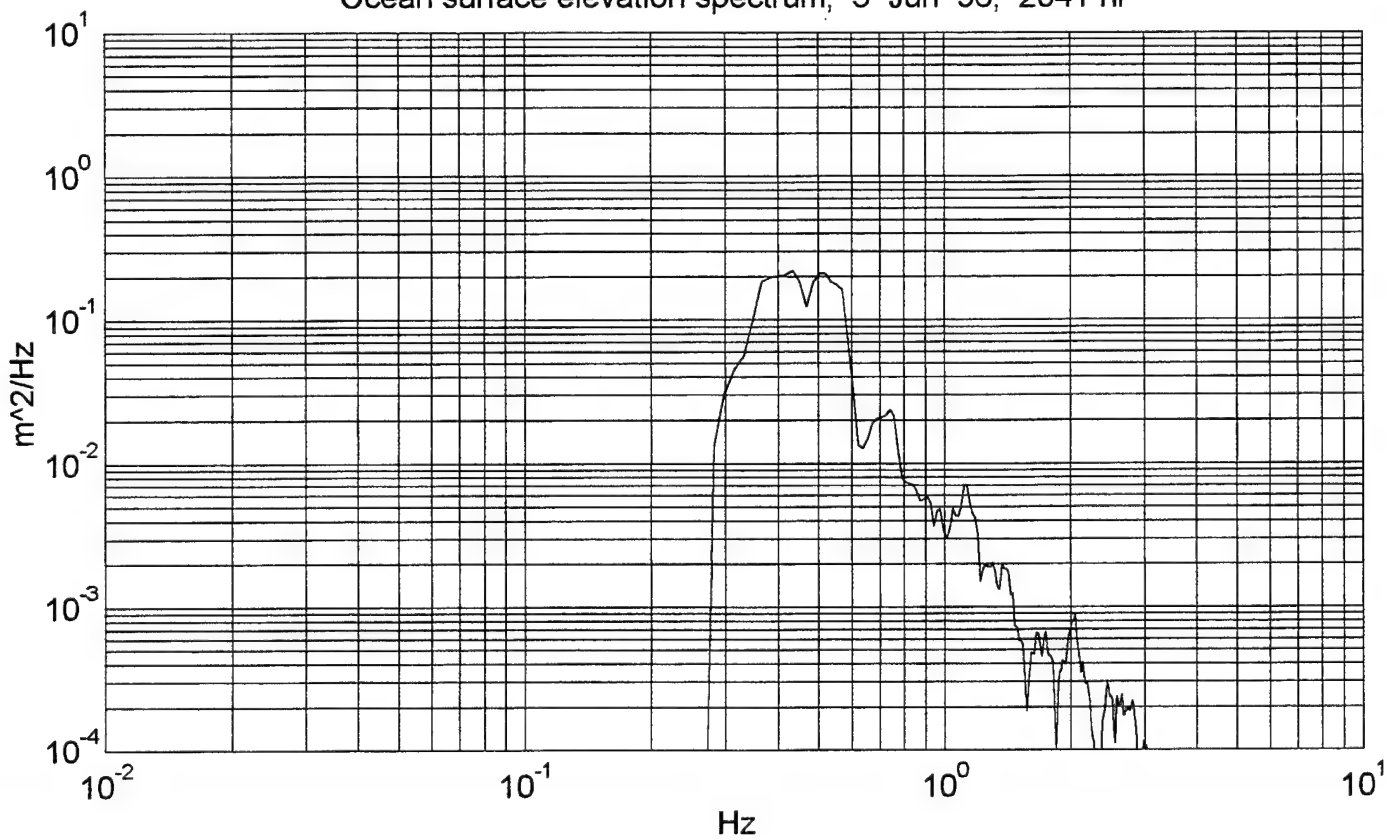
Ocean surface elevation spectrum, 5 Jun 96, 2000 hr



Temperature spectrum, 5 Jun 96, 2041 hr

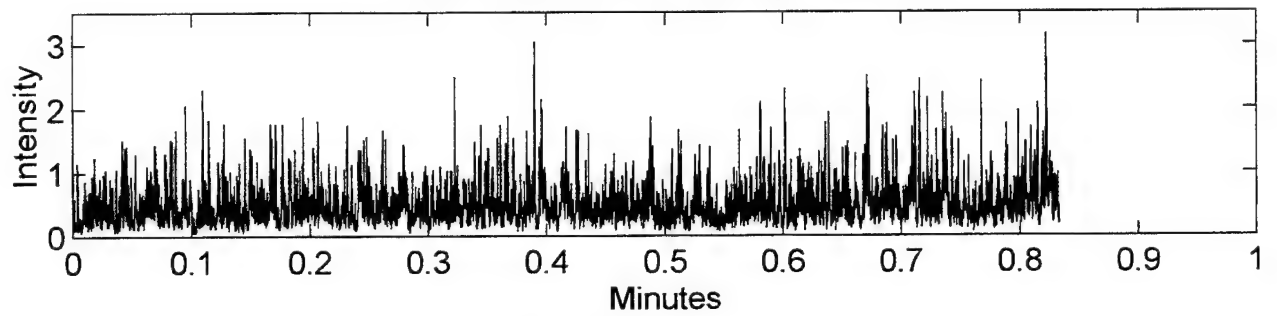


Ocean surface elevation spectrum, 5 Jun 96, 2041 hr

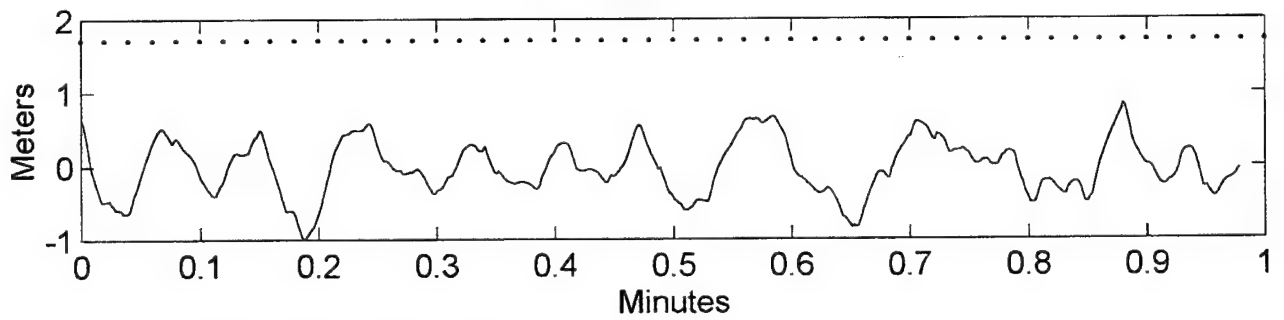


II. OPTICAL SIGNAL INTENSITY AND DISTRIBUTION AND THE CORRESPONDING OCEAN SURFACE WAVES

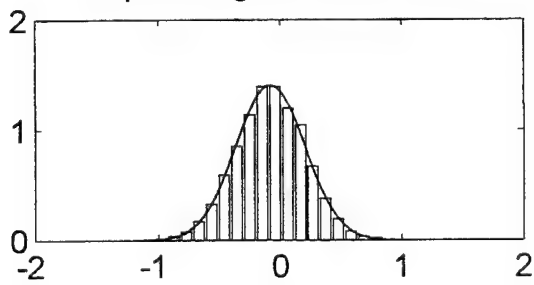
Optical signal, 30 May 96, 1225 hr



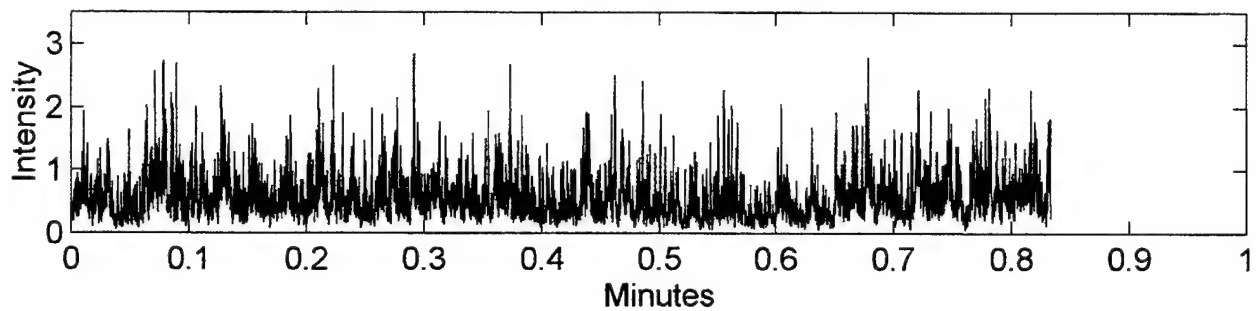
Ocean surface waves



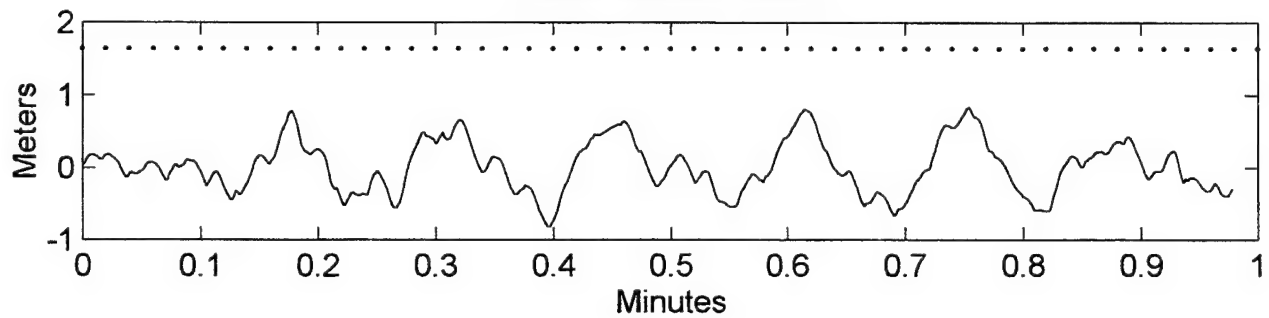
Optical signal distribution



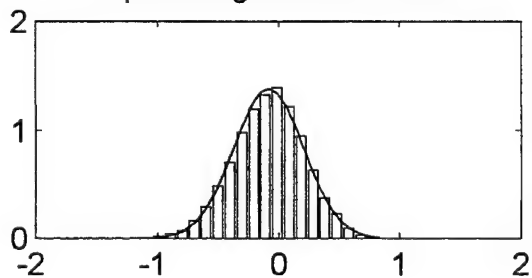
Optical signal, 30 May 96, 1230 hr



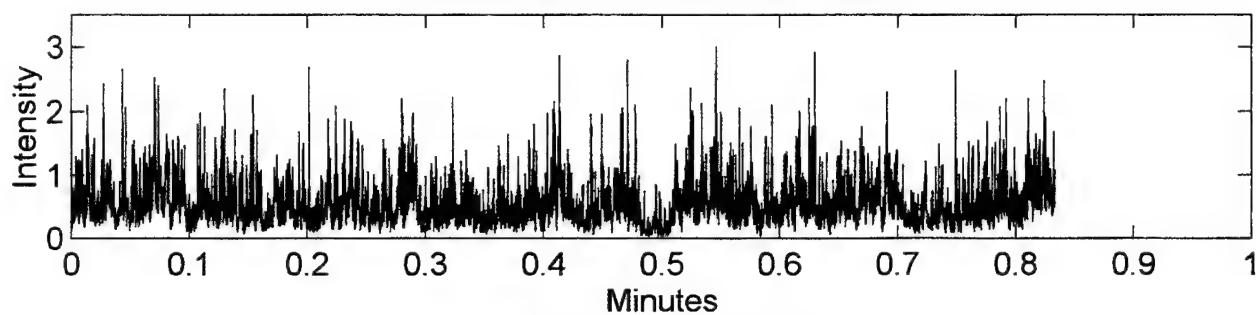
Ocean surface waves



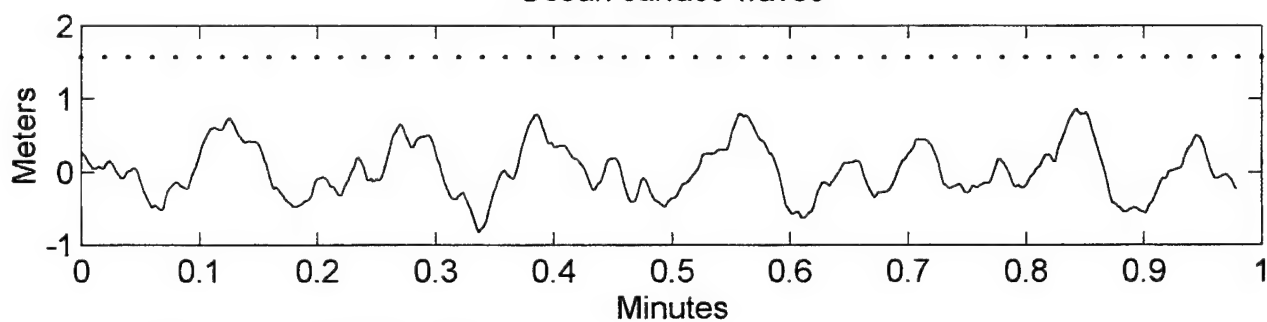
Optical signal distribution



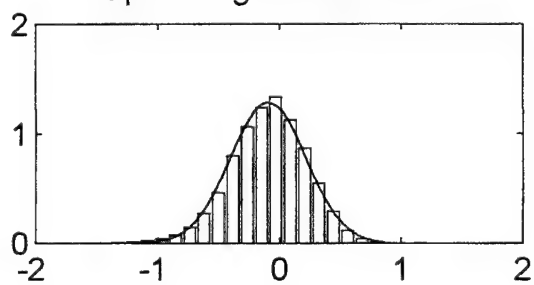
Optical signal, 30 May 96, 1233 hr



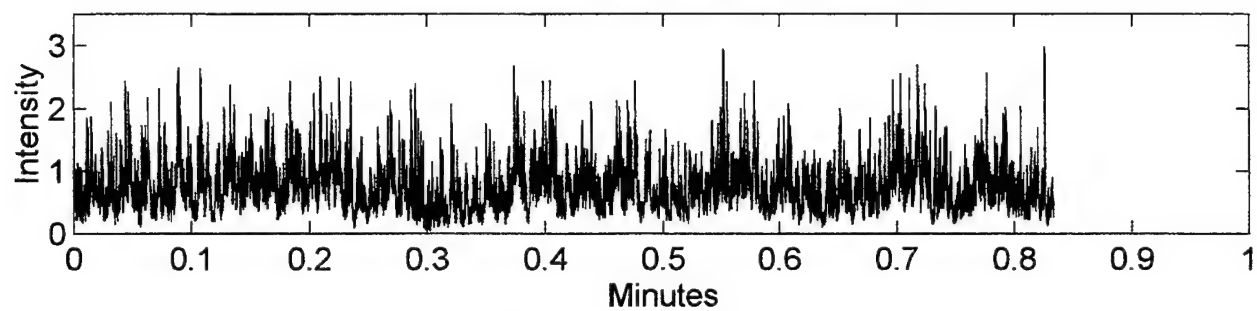
Ocean surface waves



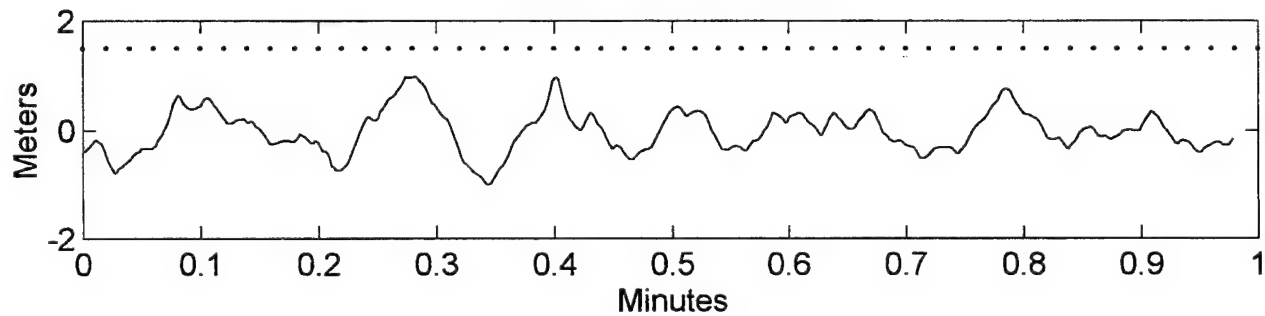
Optical signal distribution



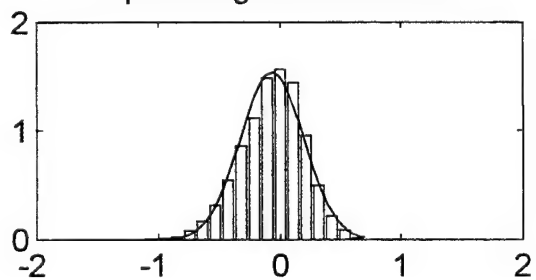
Optical signal, 30 May 96, 1236 hr



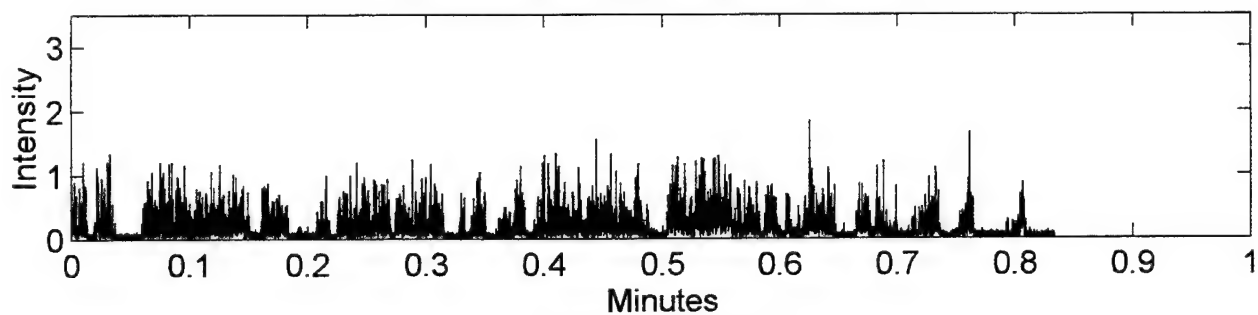
Ocean surface waves



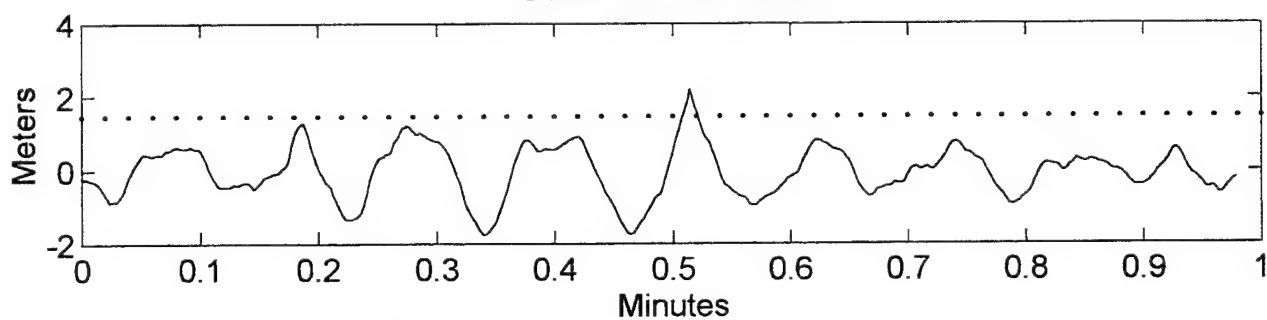
Optical signal distribution



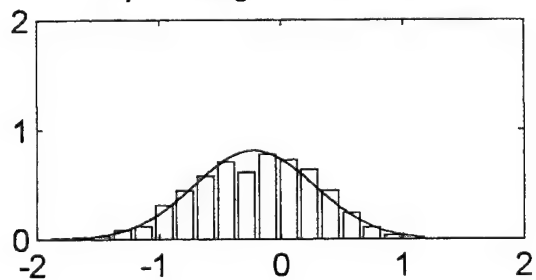
Optical signal, 30 May 96, 1838 hr



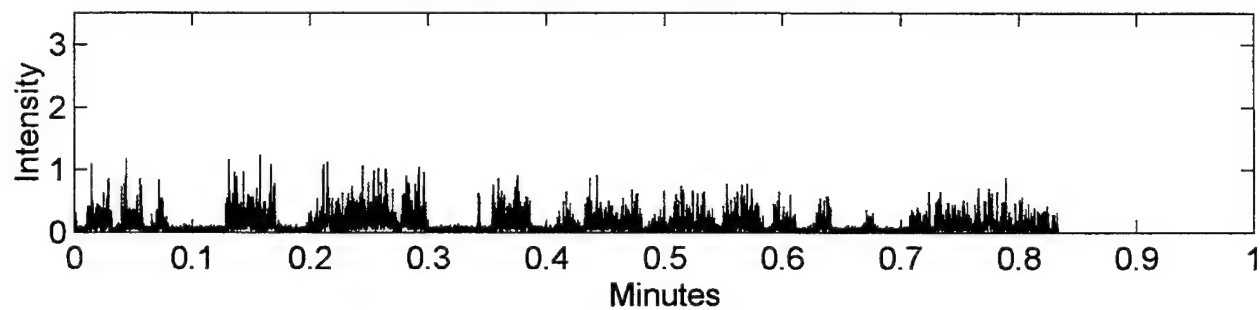
Ocean surface waves



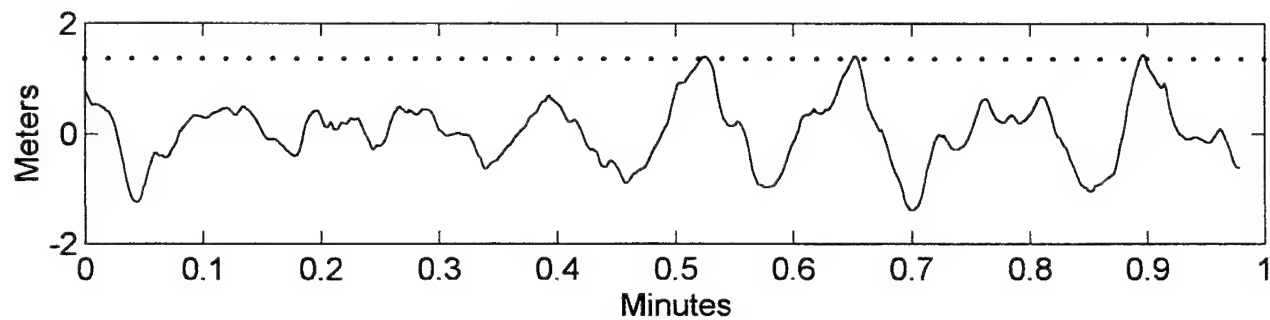
Optical signal distribution



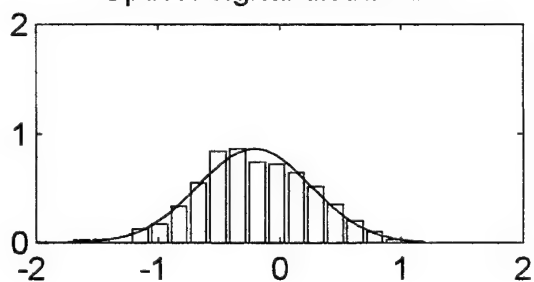
Optical signal, 30 May 96, 1843 hr



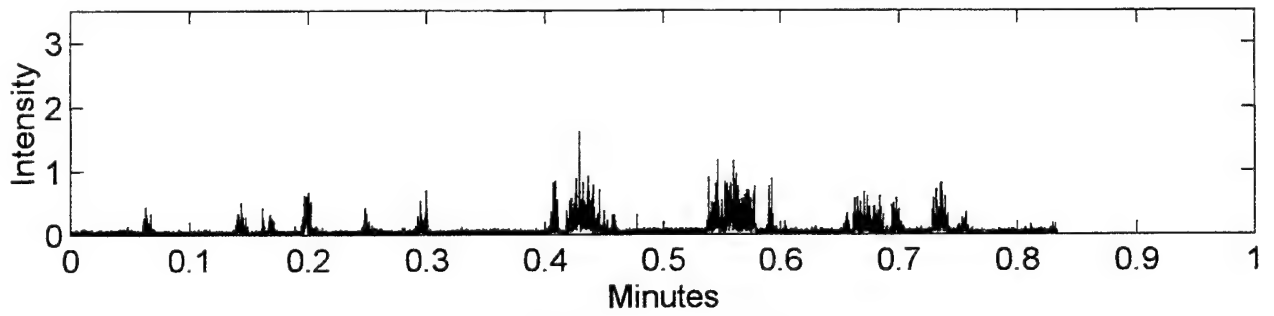
Ocean surface waves



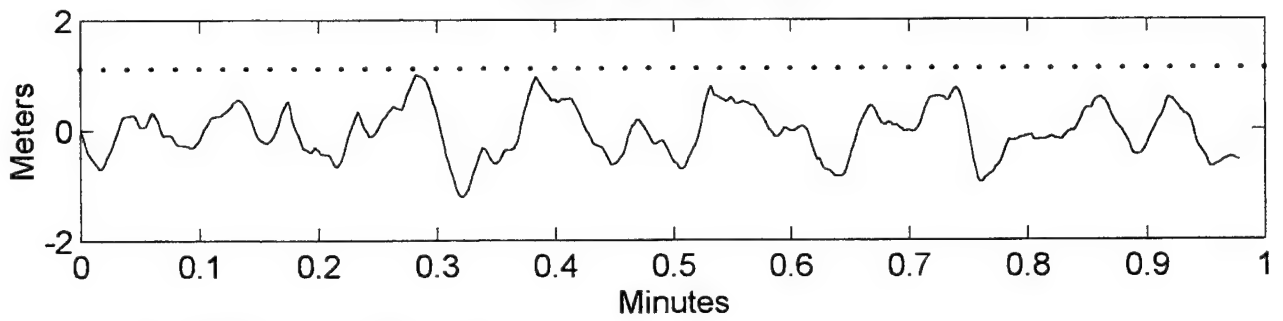
Optical signal distribution



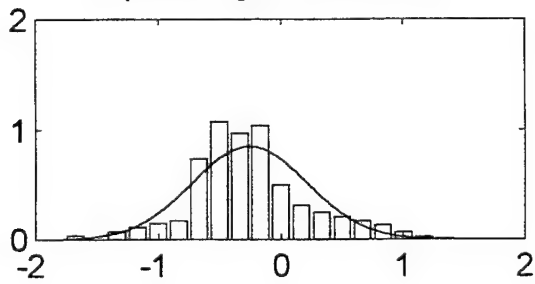
Optical signal, 30 May 96, 1859 hr



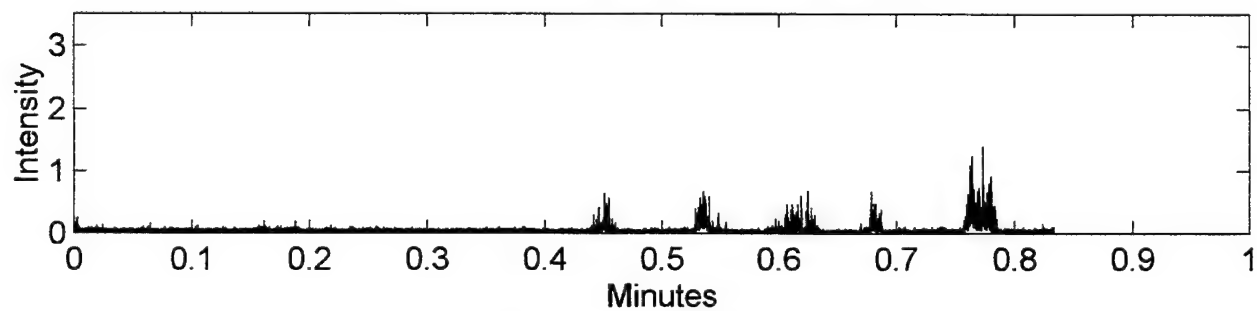
Ocean surface waves



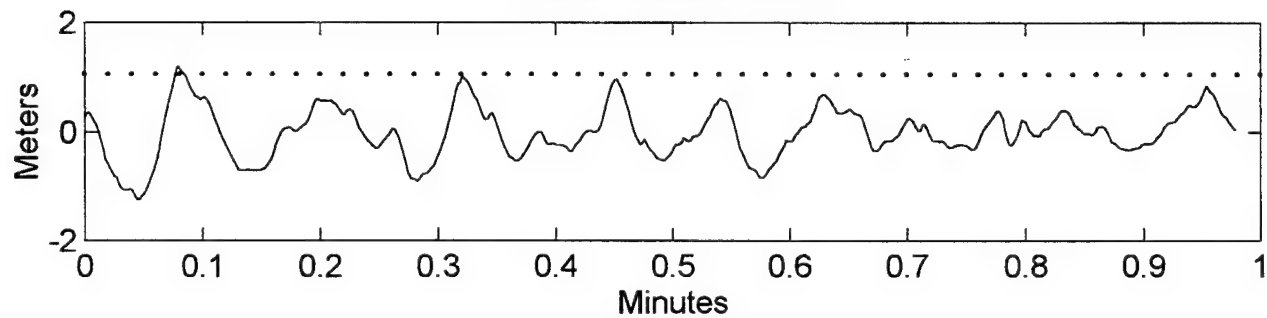
Optical signal distribution



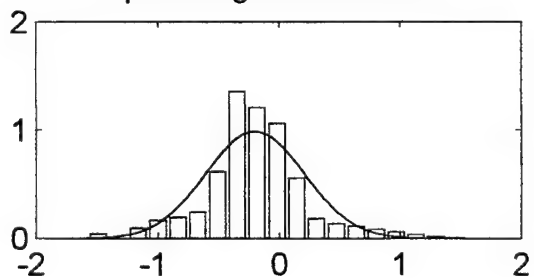
Optical signal, 30 May 96, 1903 hr



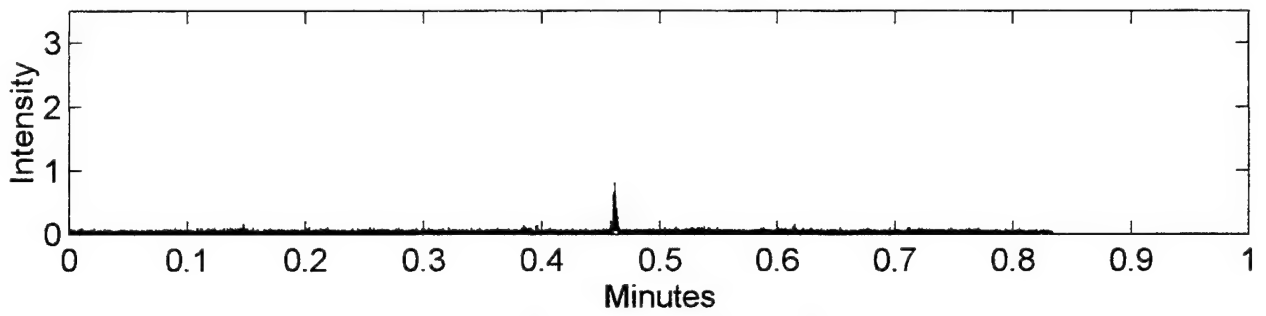
Ocean surface waves



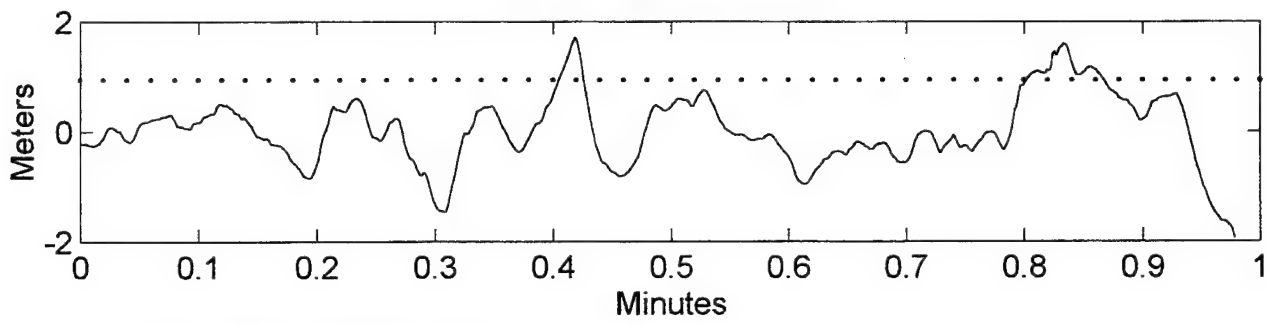
Optical signal distribution



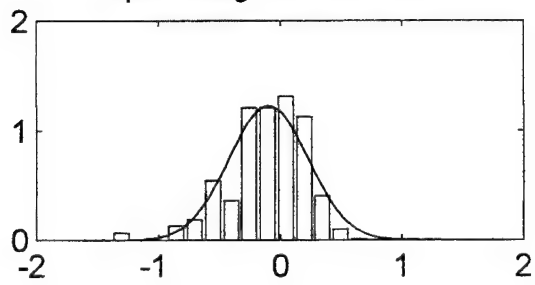
Optical signal, 30 May 96, 1909 hr



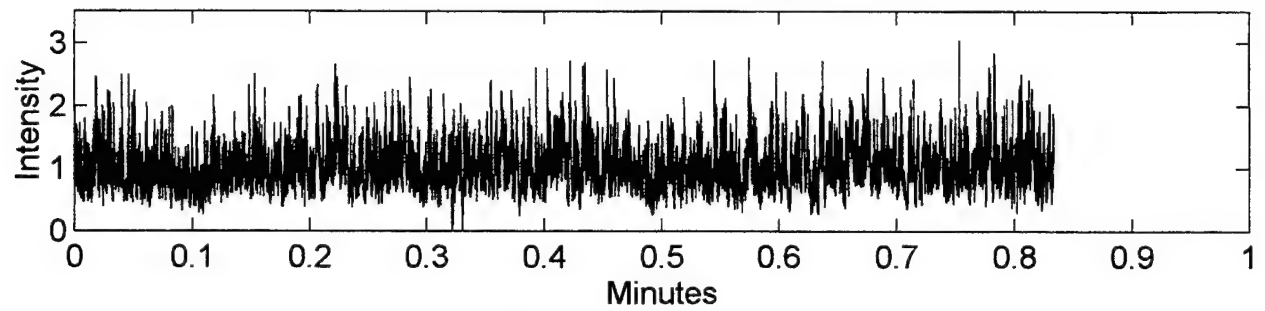
Ocean surface waves



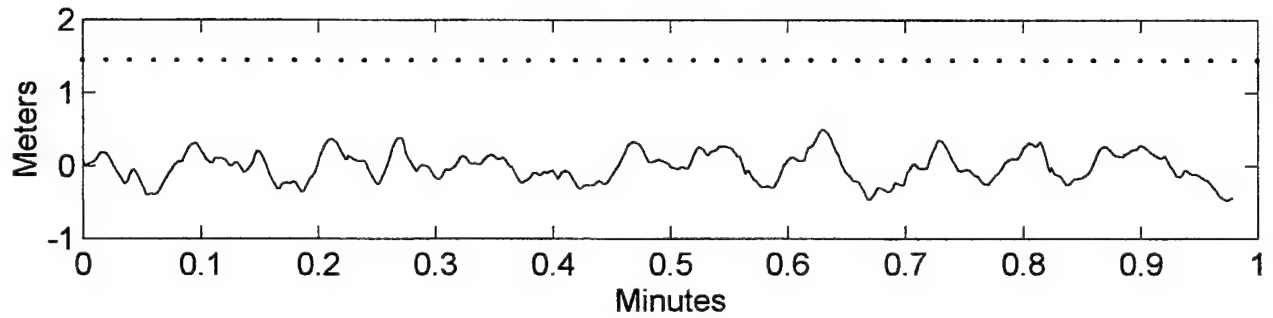
Optical signal distribution



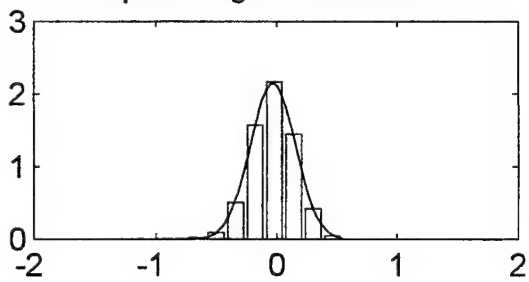
Optical signal, 31 May 96, 943 hr



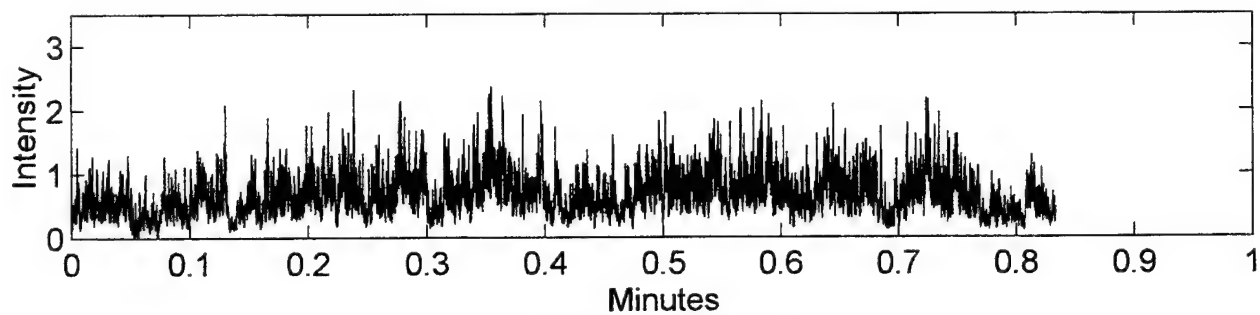
Ocean surface waves



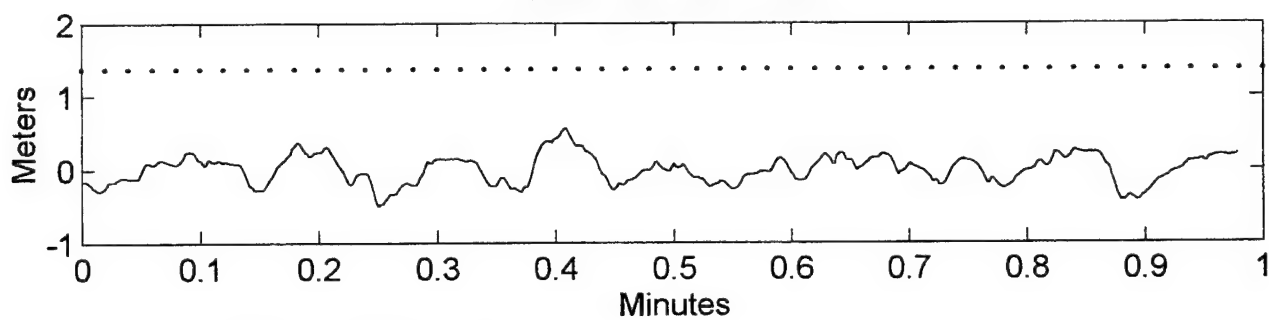
Optical signal distribution



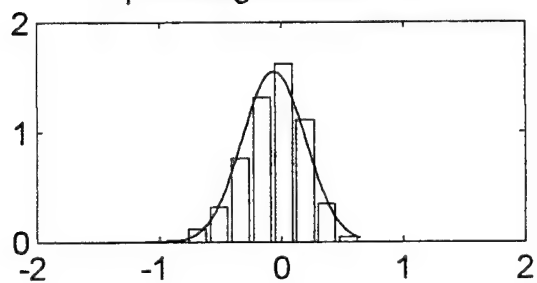
Optical signal, 31 May 96, 946 hr



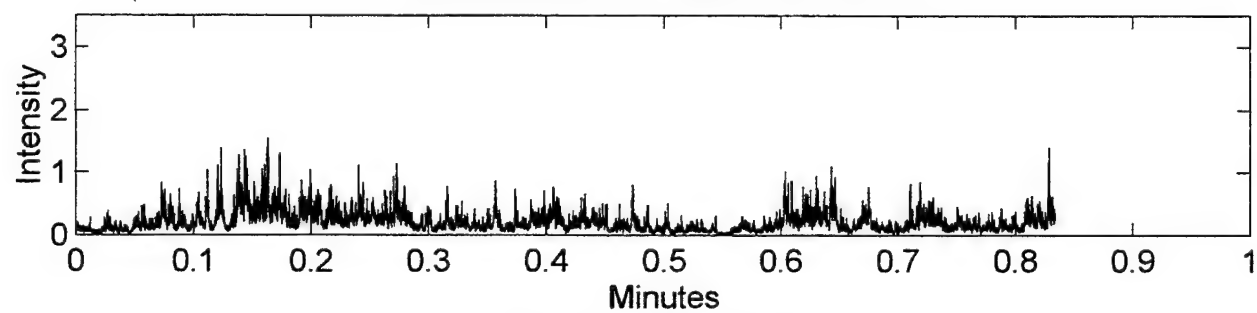
Ocean surface waves



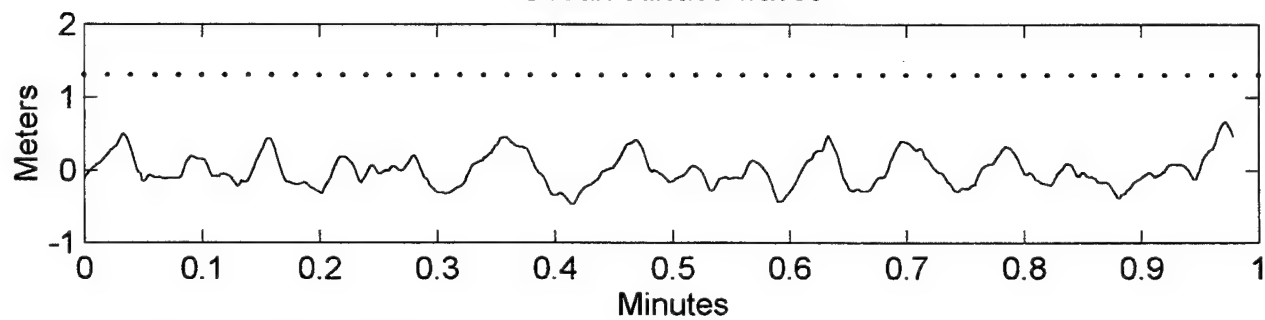
Optical signal distribution



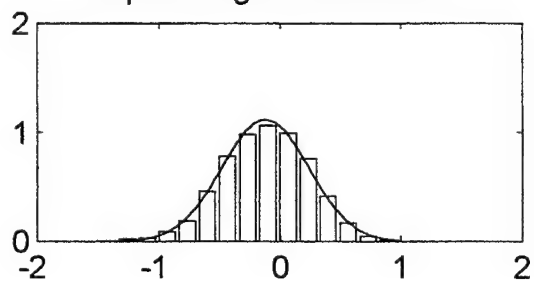
Optical signal, 31 May 96, 951 hr

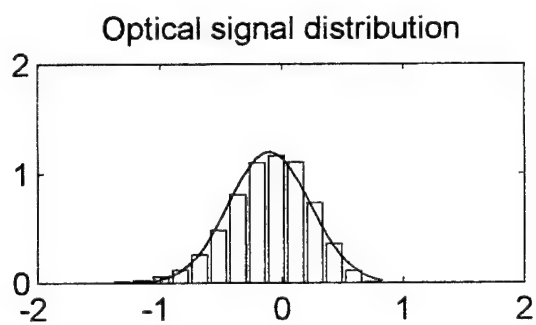
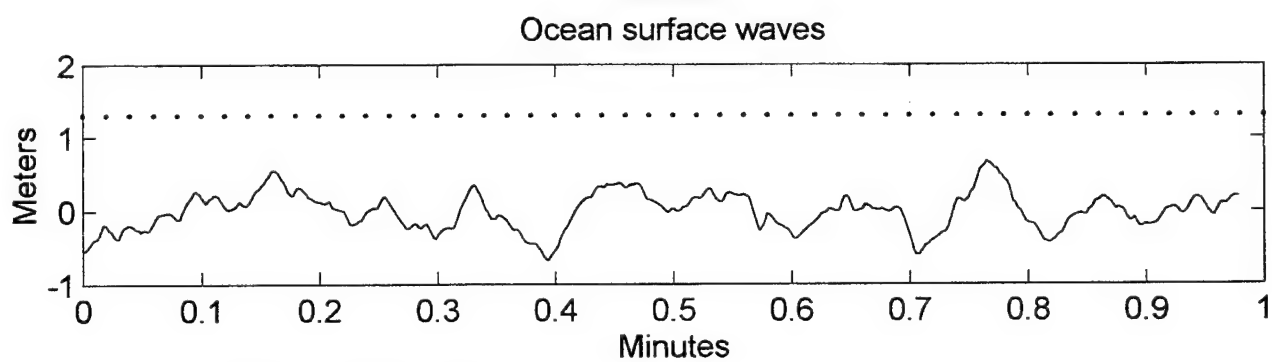
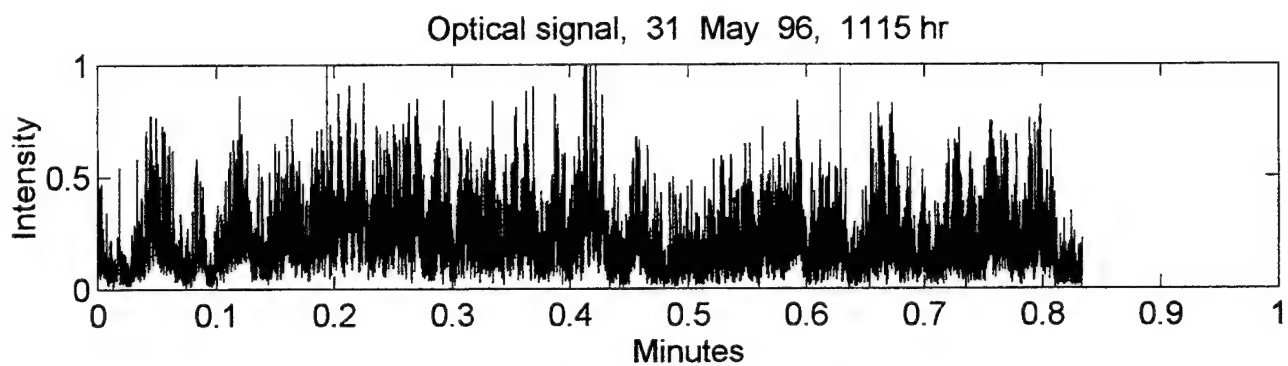


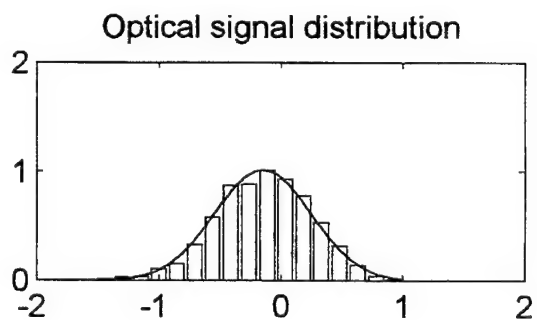
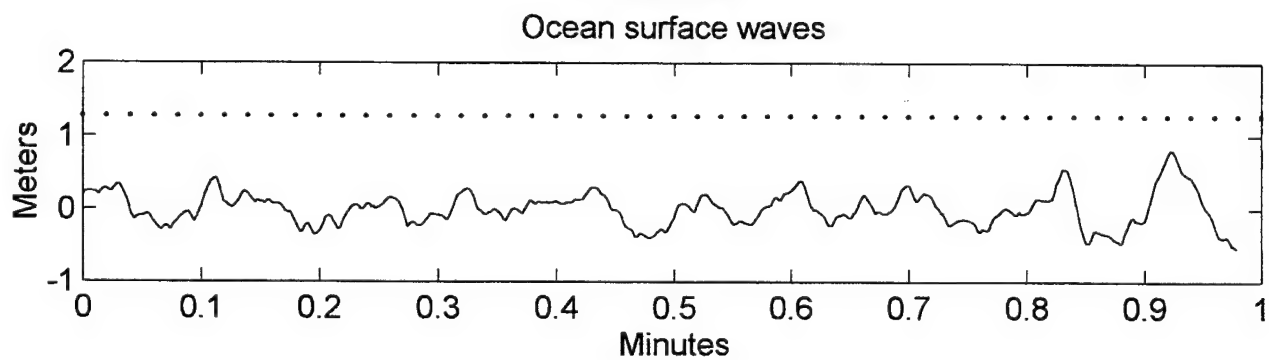
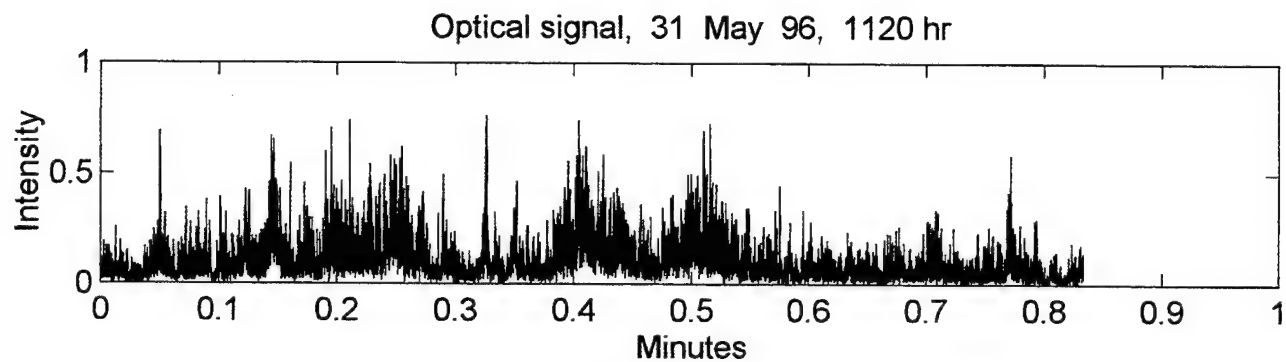
Ocean surface waves

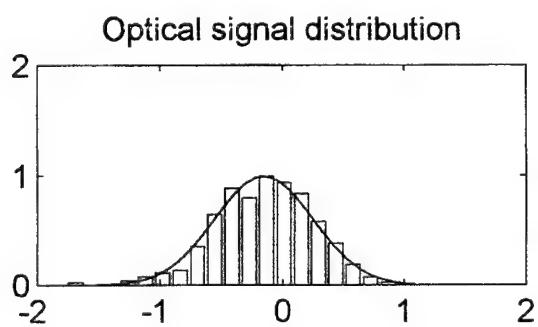
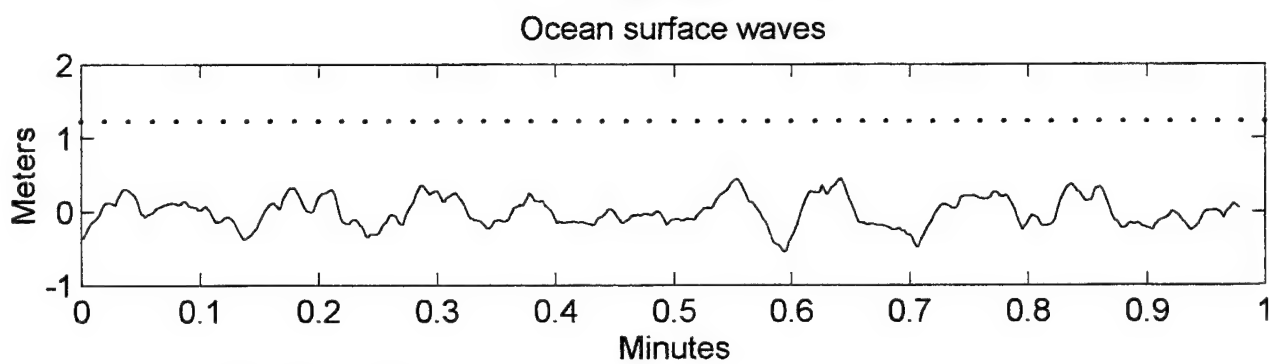
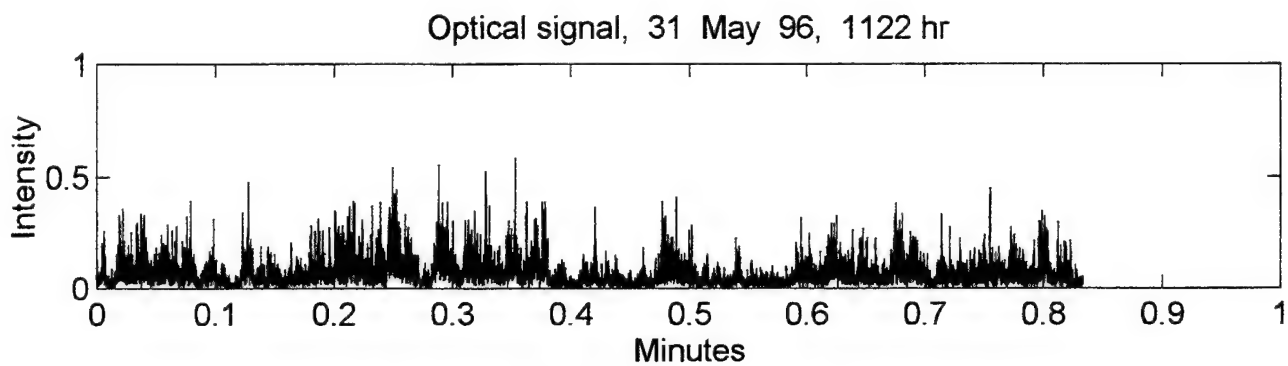


Optical signal distribution

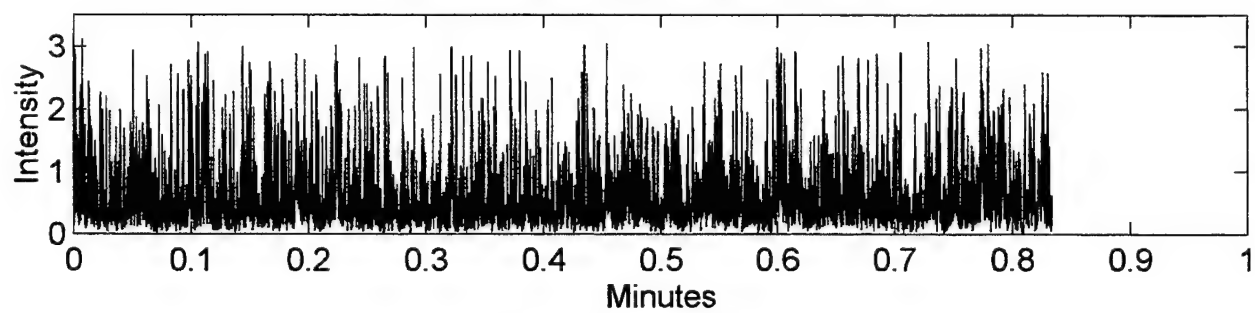




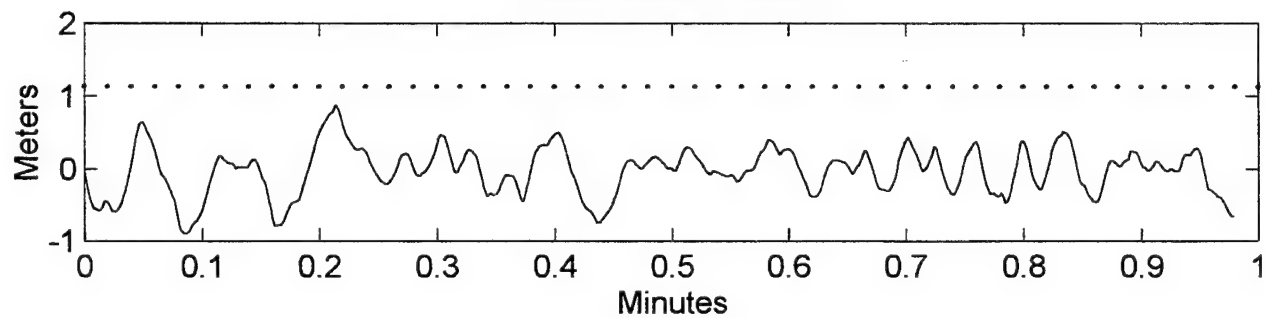




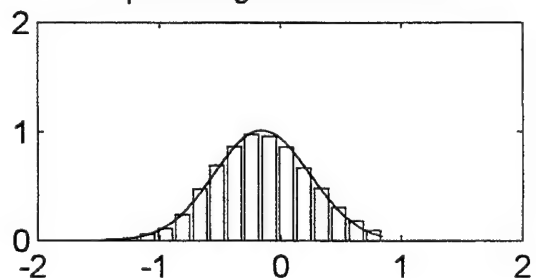
Optical signal, 31 May 96, 1830 hr



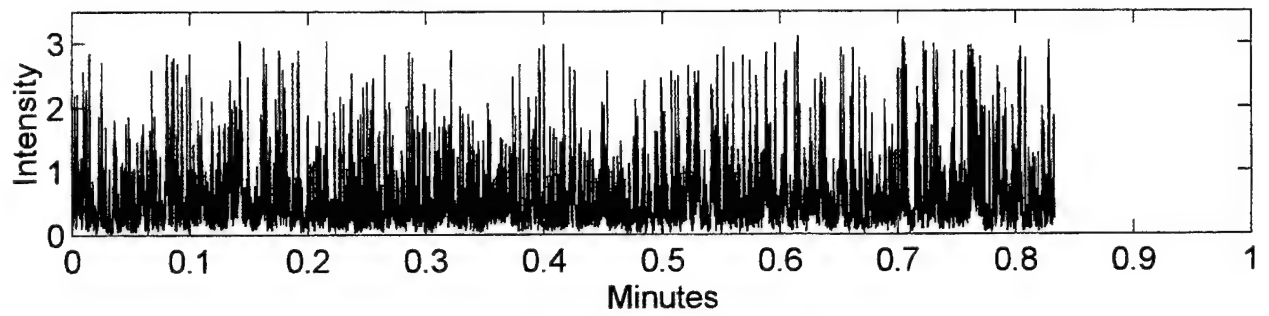
Ocean surface waves



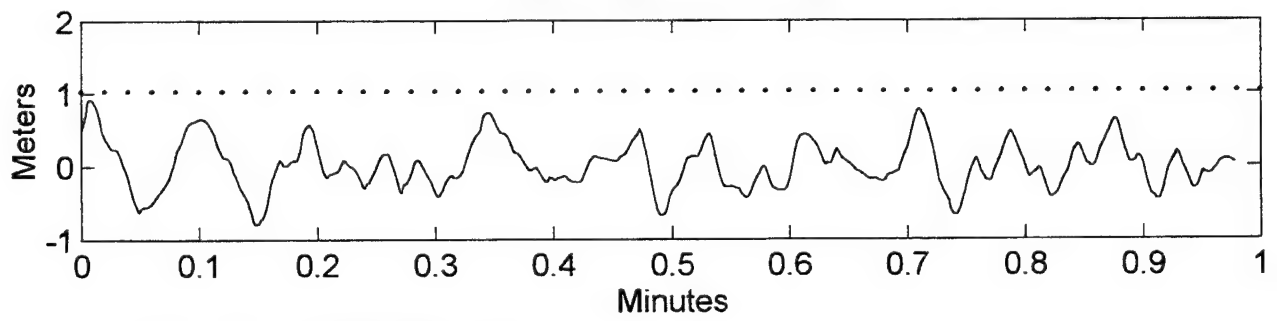
Optical signal distribution



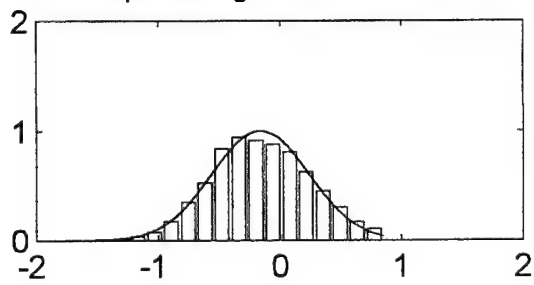
Optical signal, 31 May 96, 1834 hr



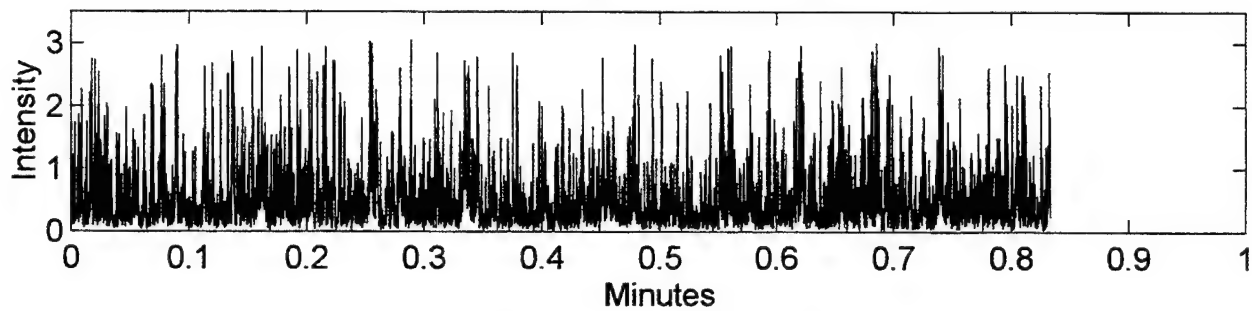
Ocean surface waves



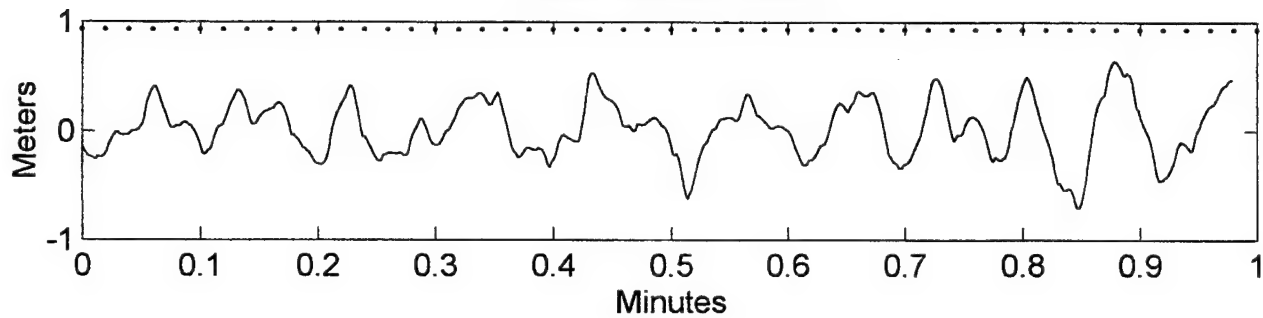
Optical signal distribution



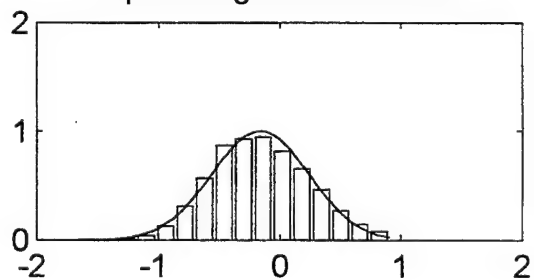
Optical signal, 31 May 96, 1836 hr



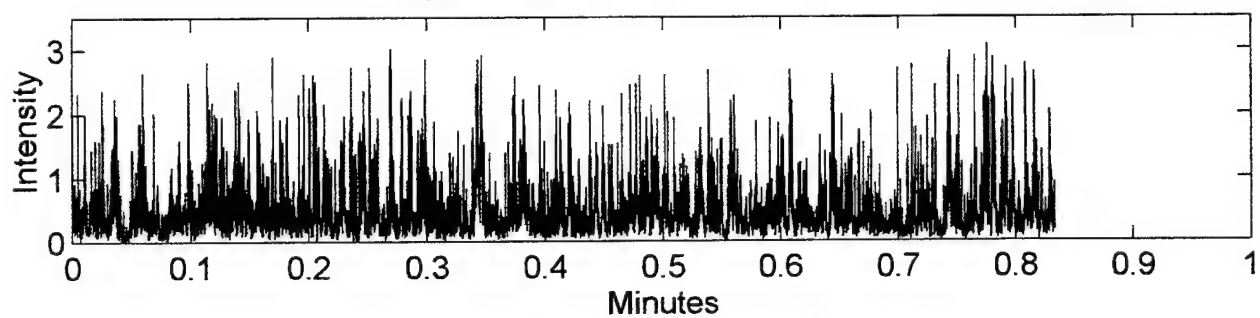
Ocean surface waves



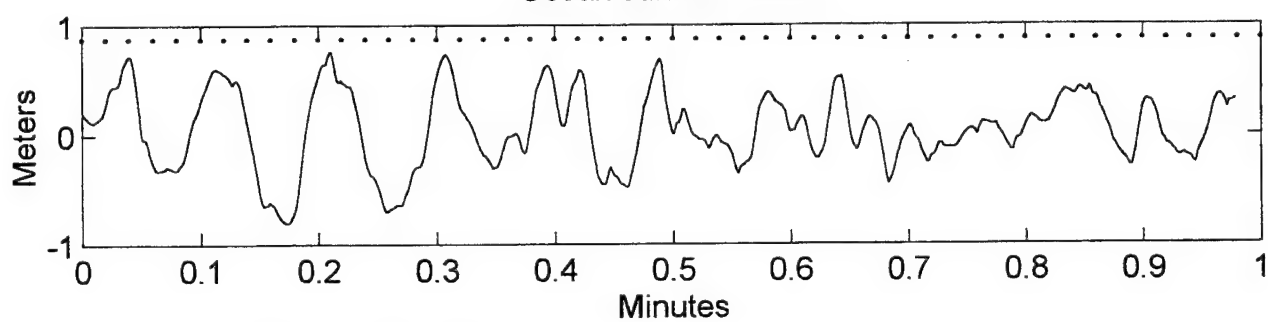
Optical signal distribution



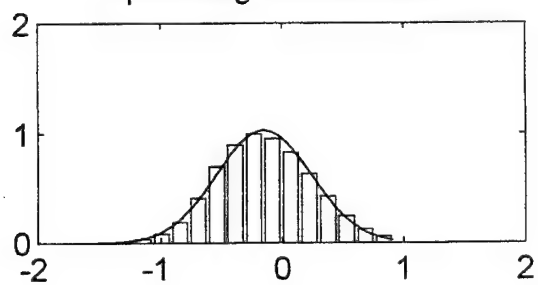
Optical signal, 31 May 96, 1839 hr

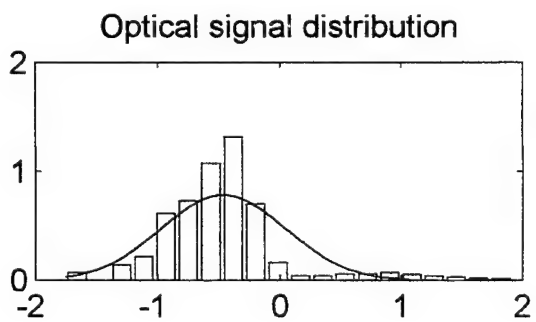
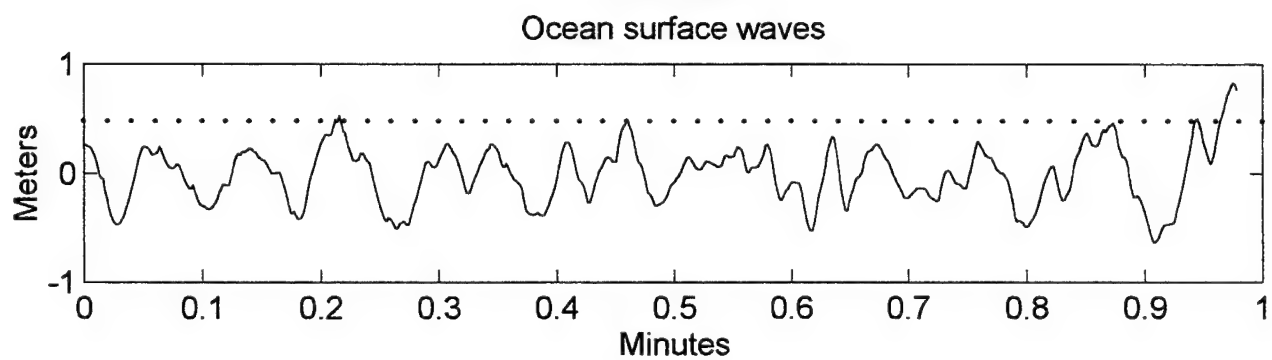
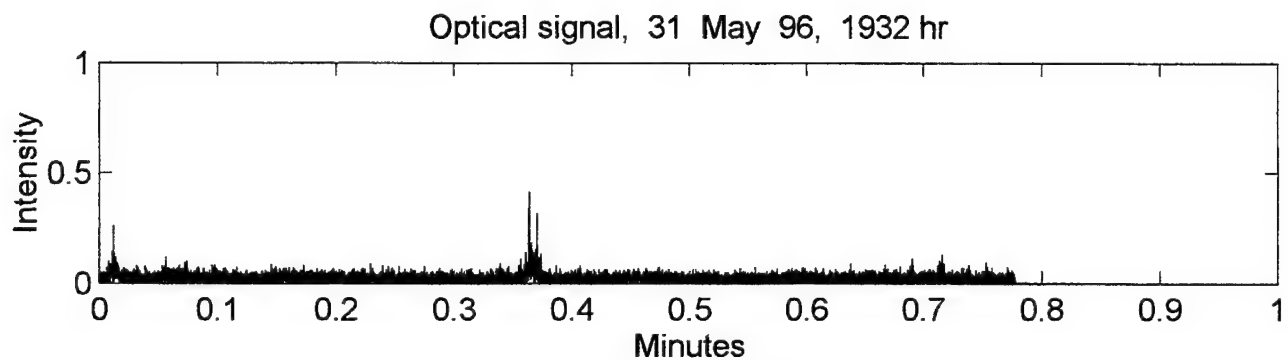


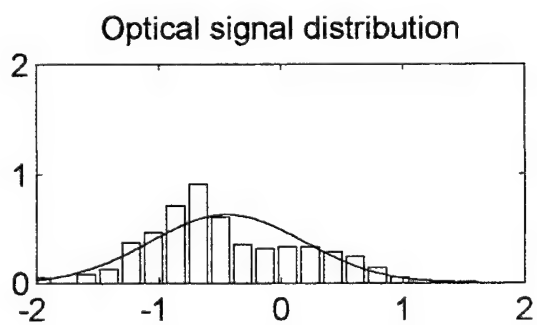
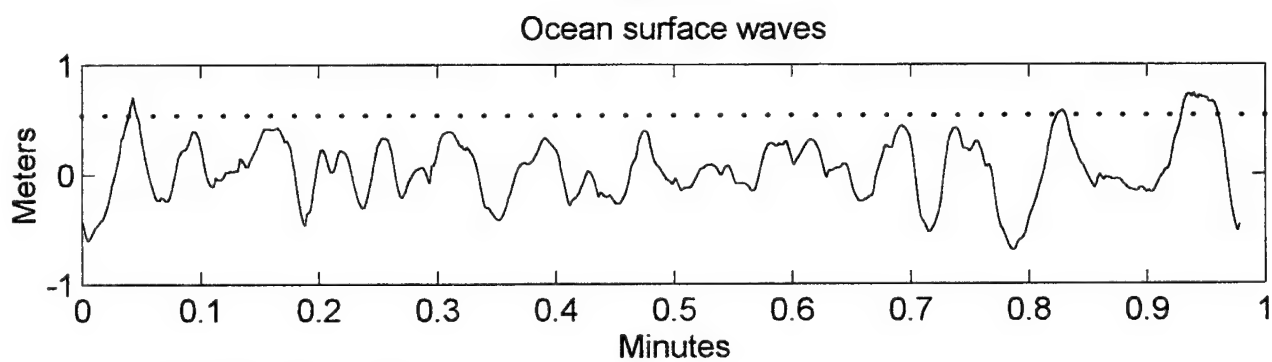
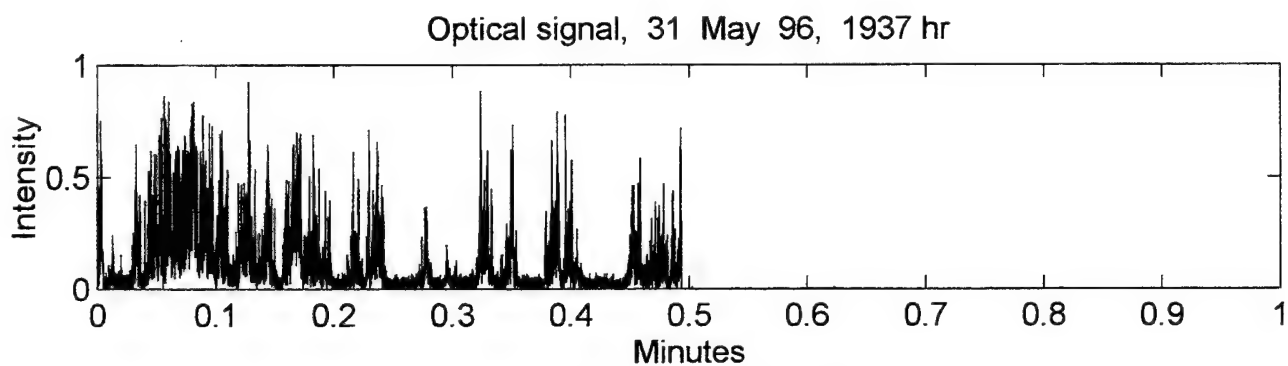
Ocean surface waves



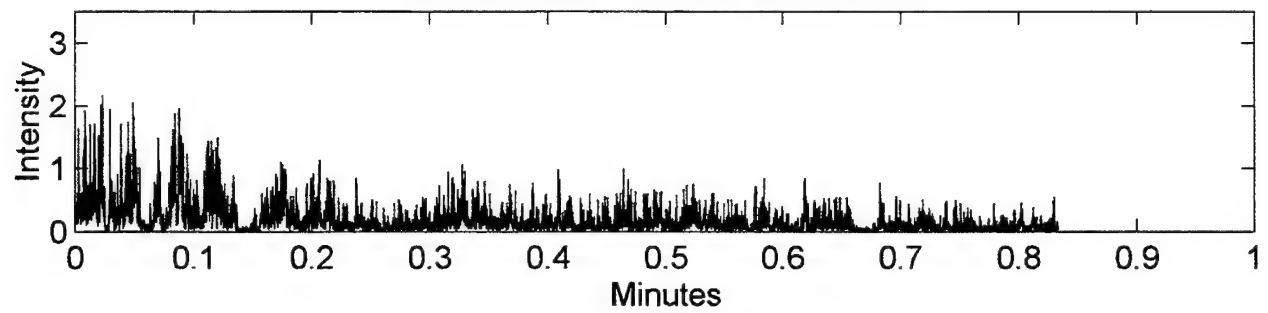
Optical signal distribution



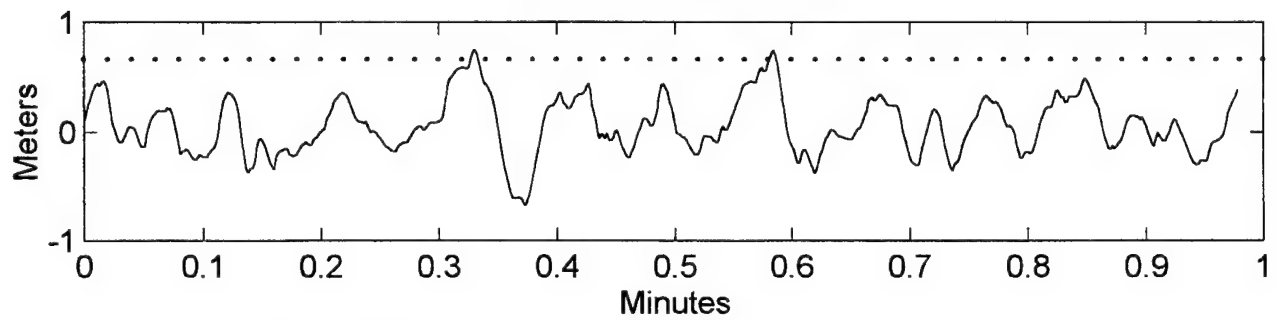




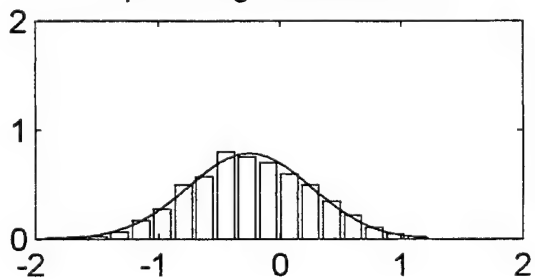
Optical signal, 31 May 96, 1948 hr



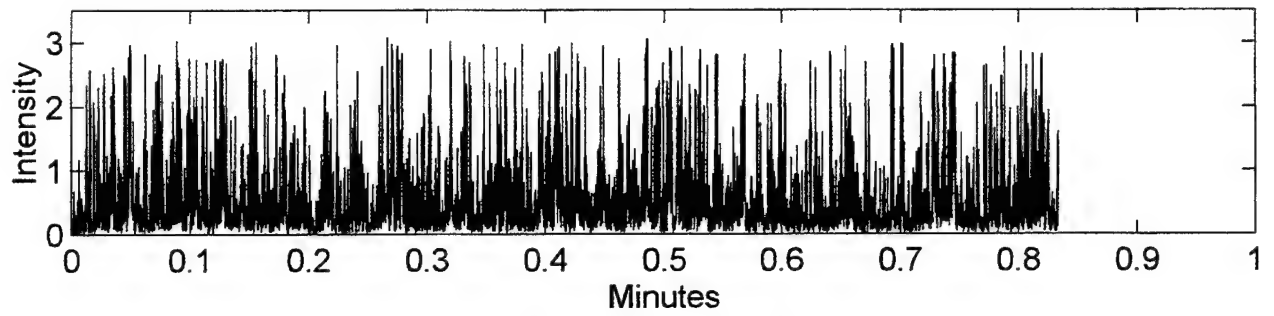
Ocean surface waves



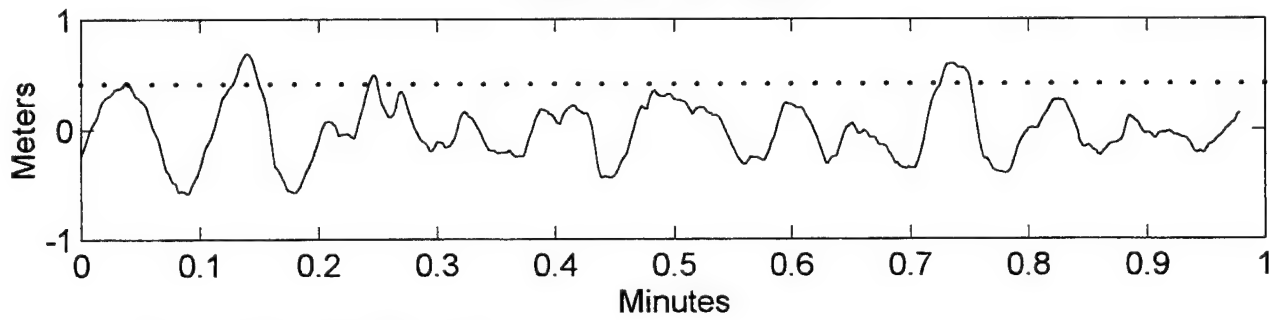
Optical signal distribution



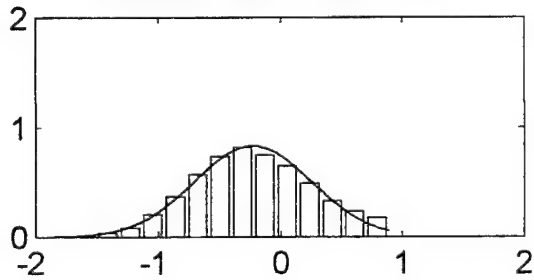
Optical signal, 1 Jun 96, 2208 hr



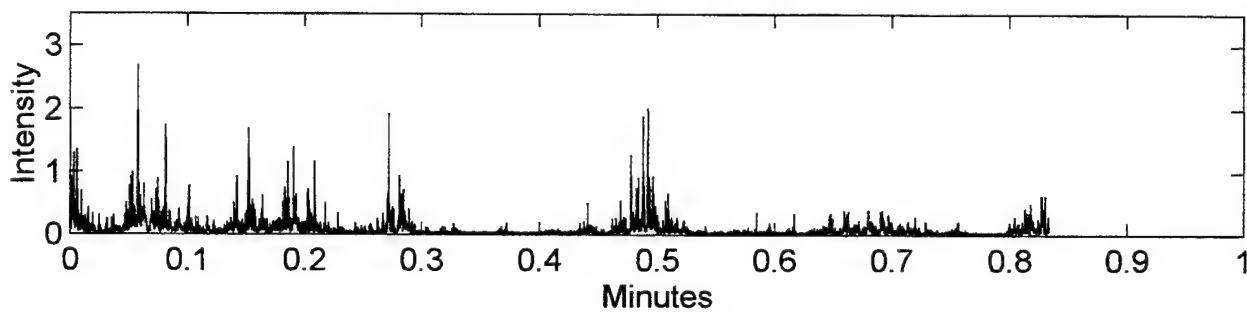
Ocean surface waves



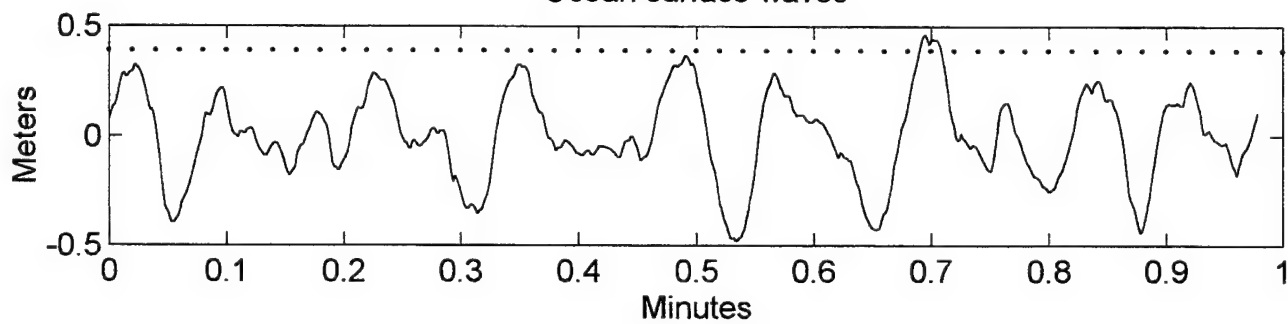
Optical signal distribution



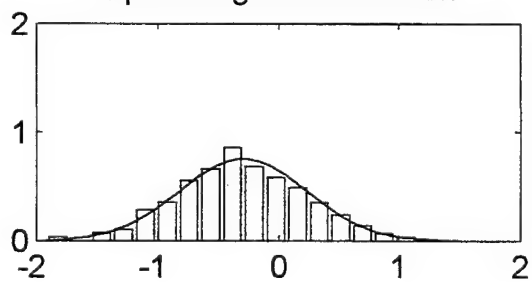
Optical signal, 1 Jun 96, 2243 hr



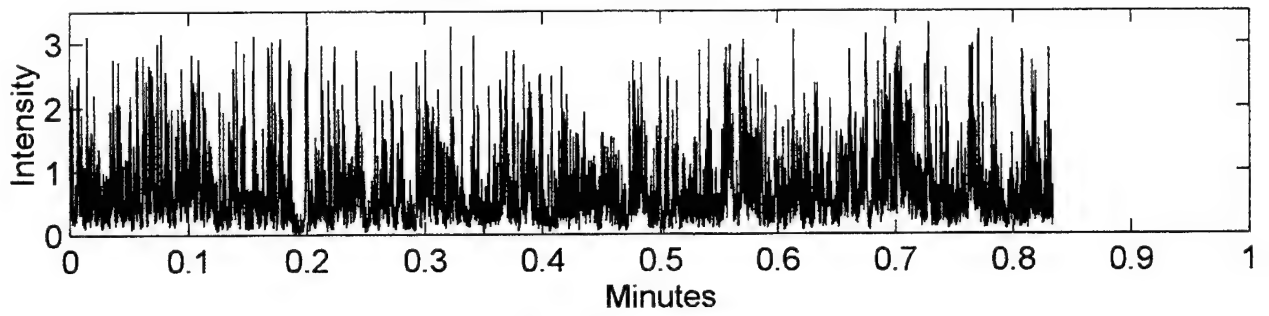
Ocean surface waves



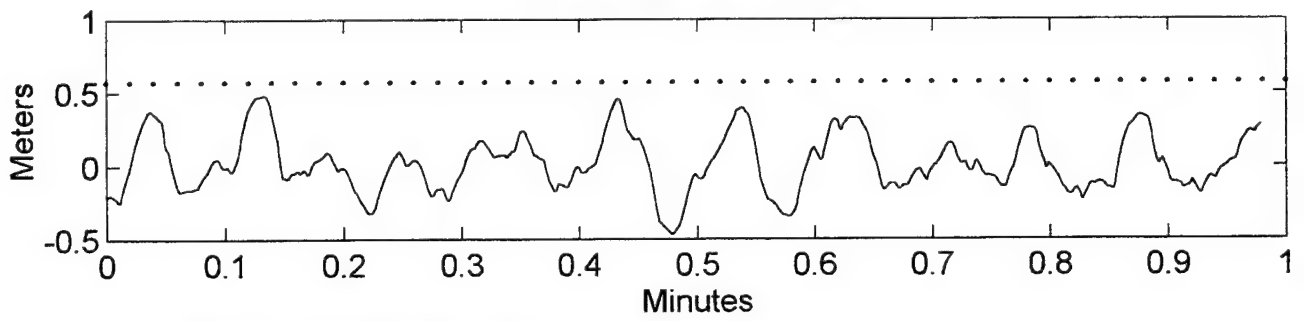
Optical signal distribution



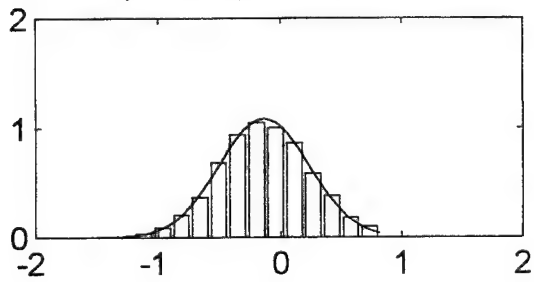
Optical signal, 1 Jun 96, 2308 hr



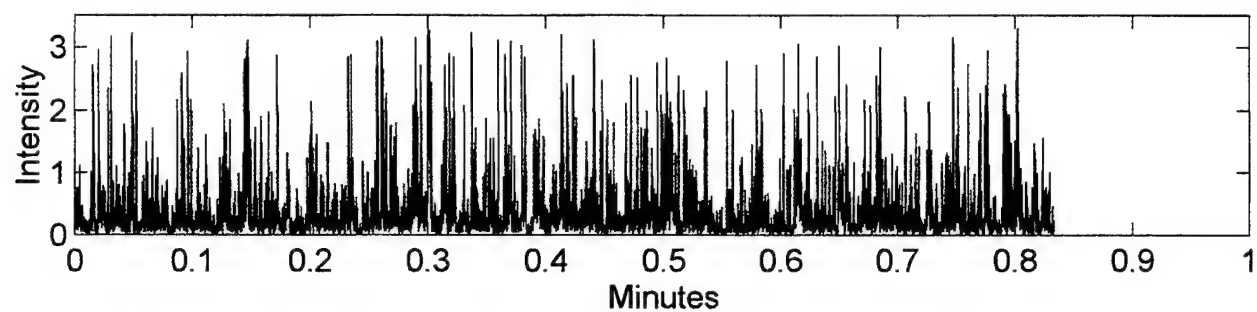
Ocean surface waves



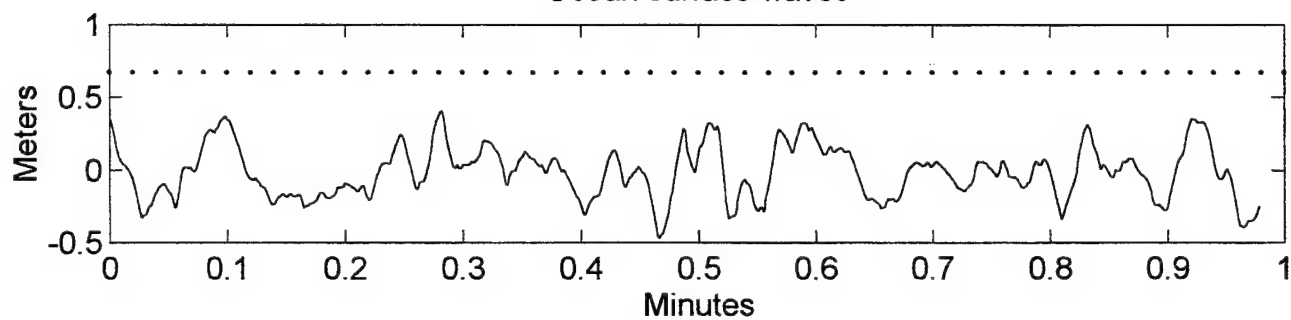
Optical signal distribution



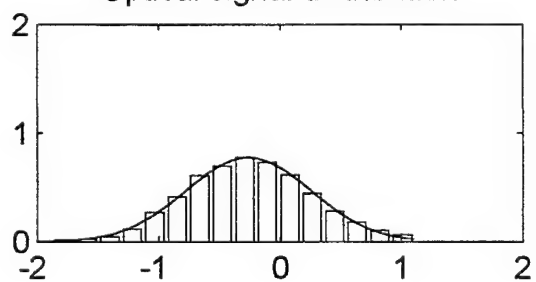
Optical signal, 2 Jun 96, 1245 hr

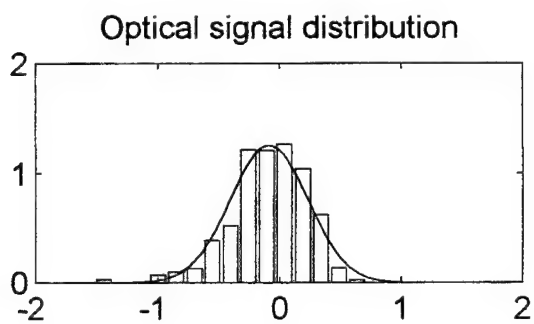
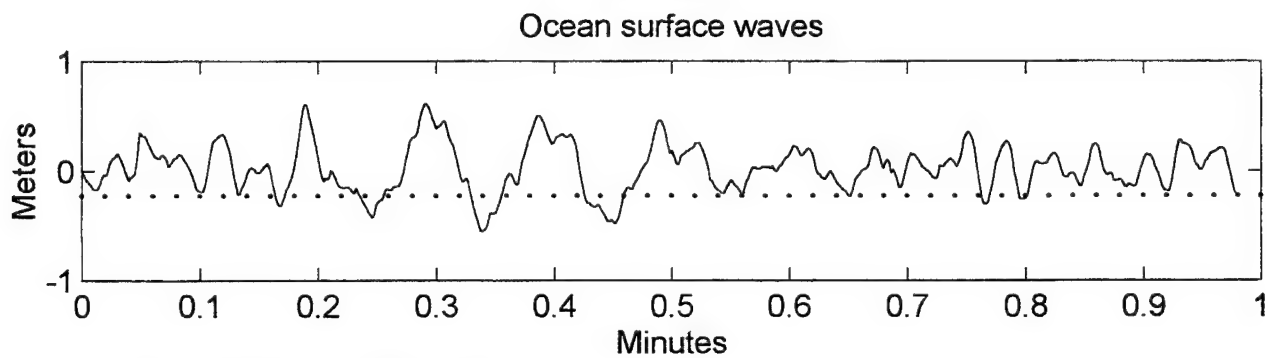
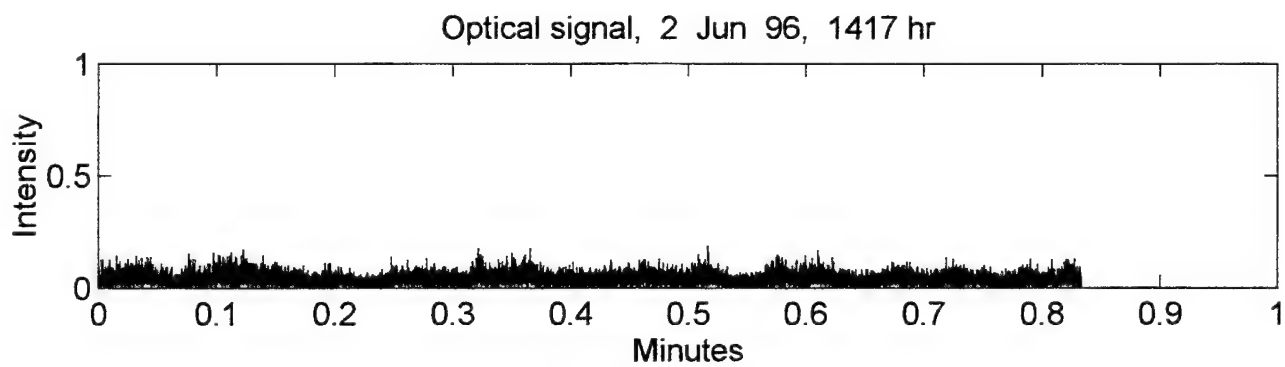


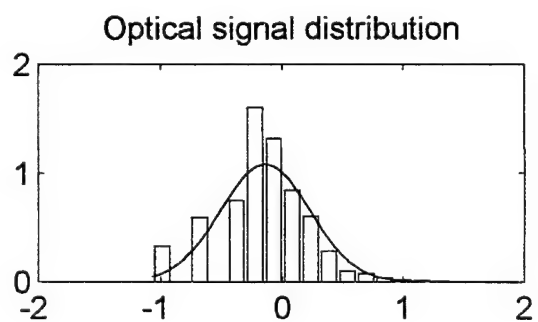
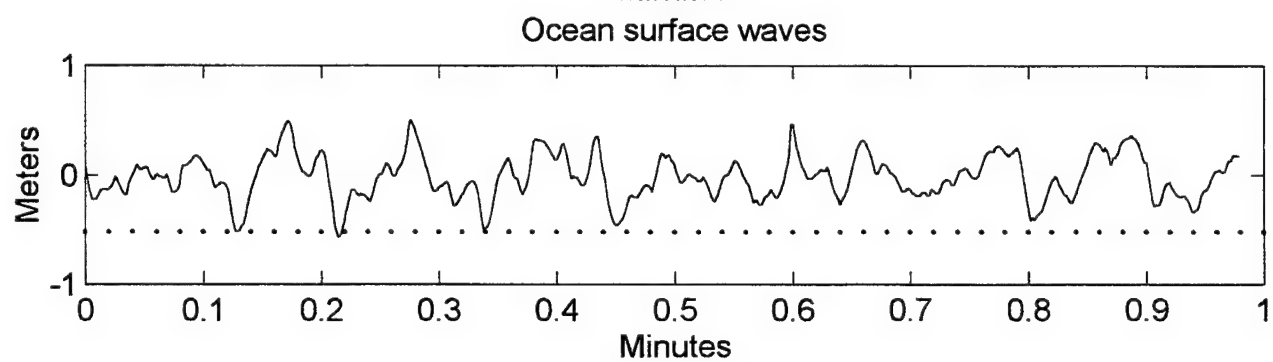
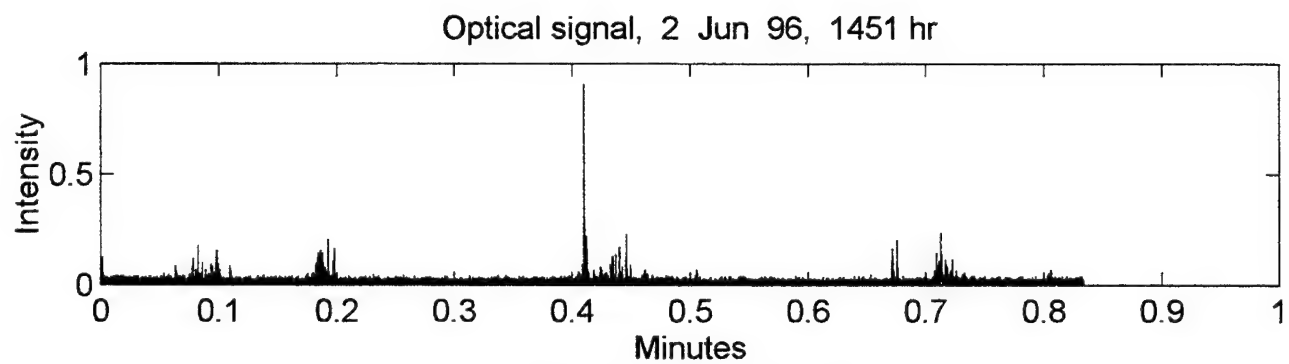
Ocean surface waves



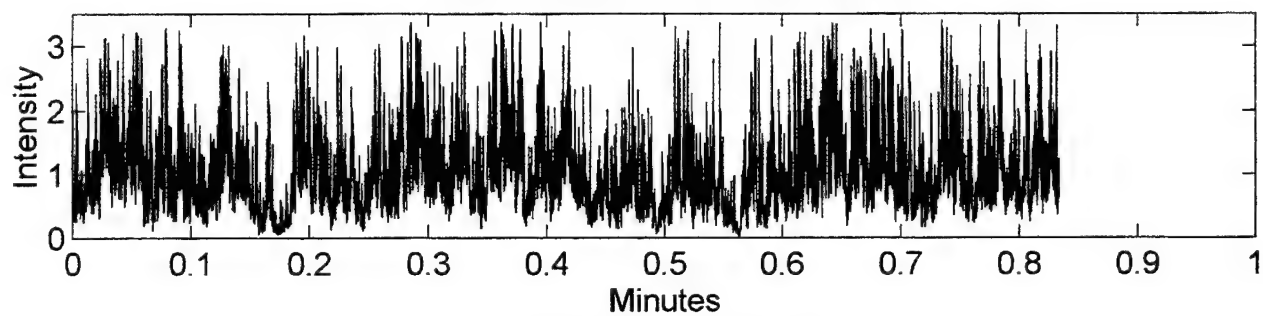
Optical signal distribution



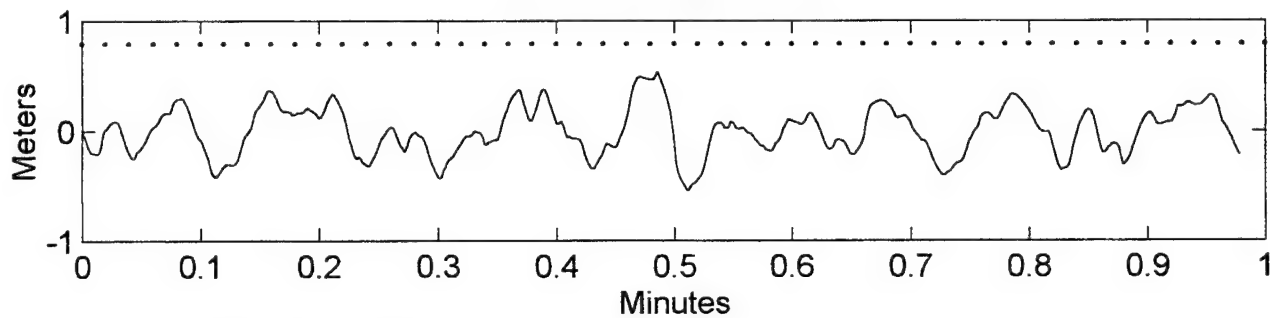




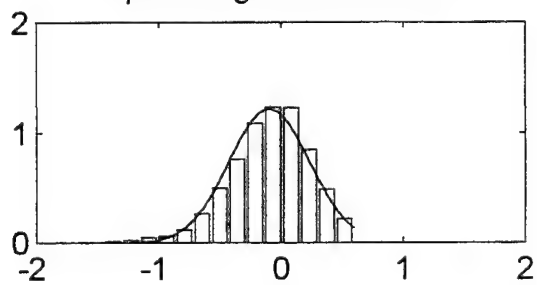
Optical signal, 3 Jun 96, 930 hr



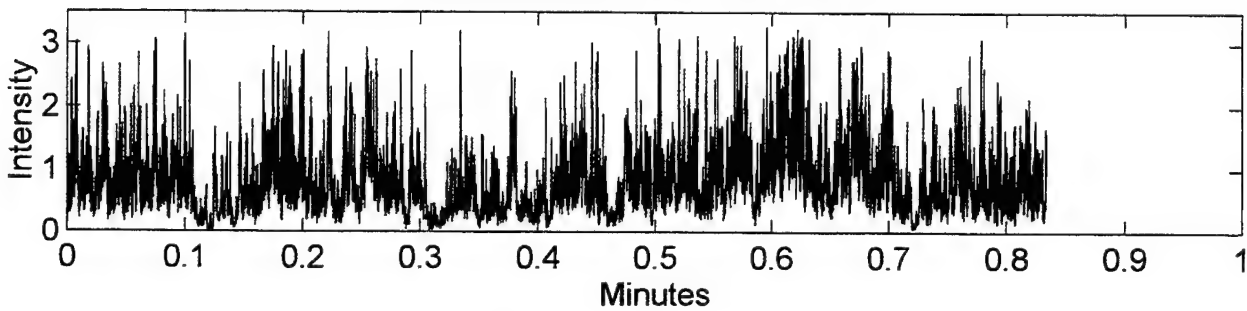
Ocean surface waves



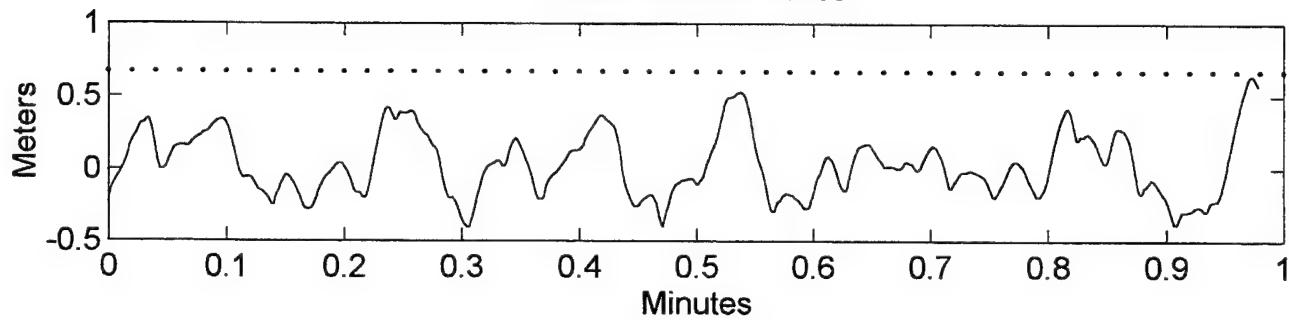
Optical signal distribution



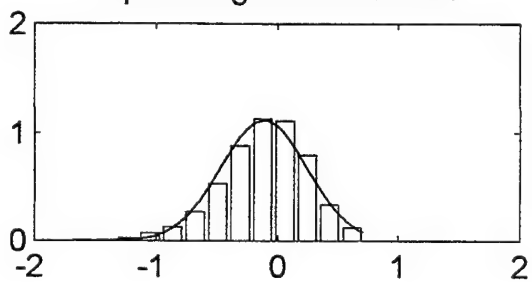
Optical signal, 3 Jun 96, 937 hr



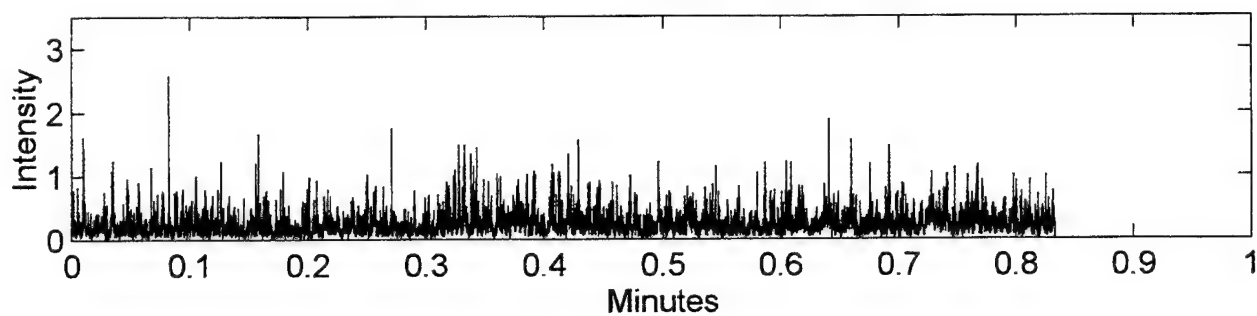
Ocean surface waves



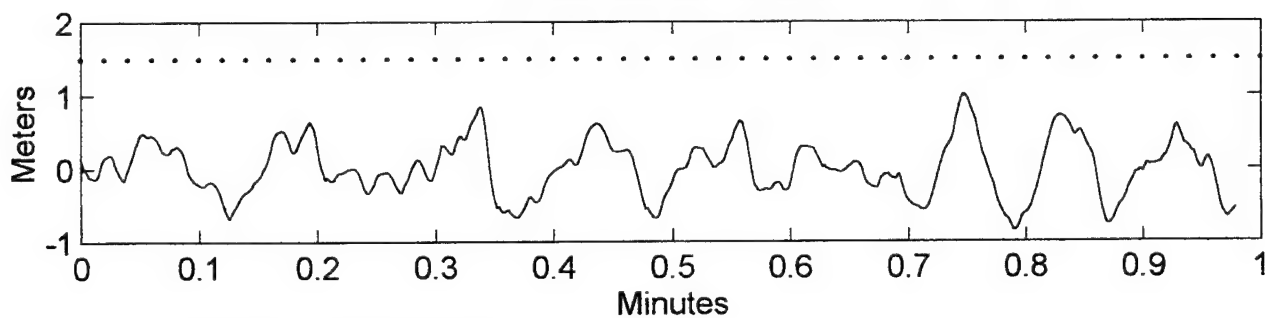
Optical signal distribution



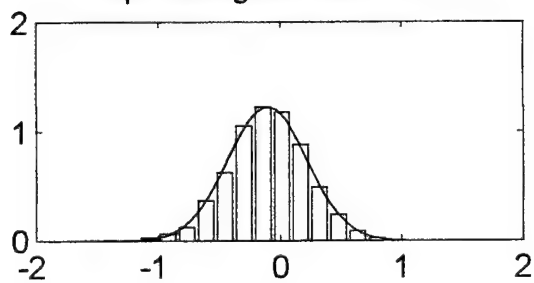
Optical signal, 3 Jun 96, 1540 hr



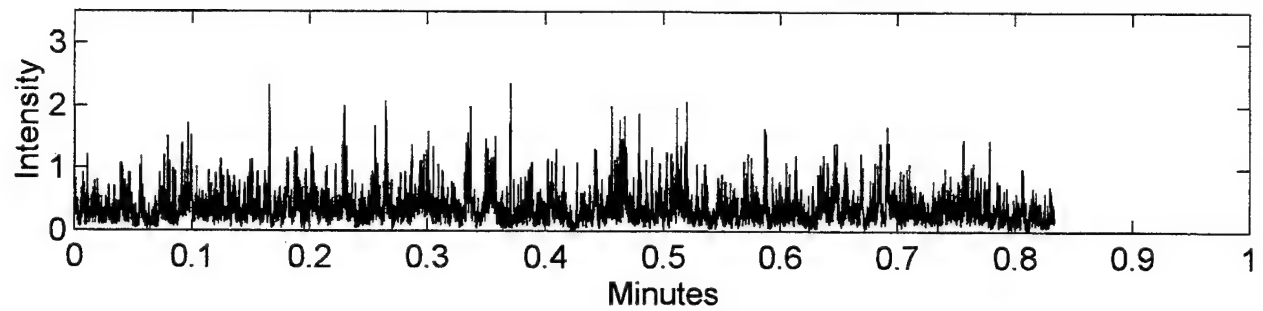
Ocean surface waves



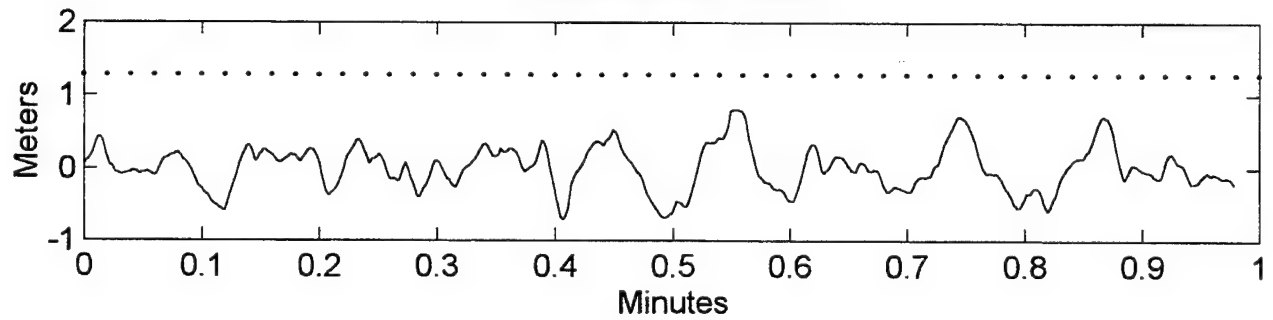
Optical signal distribution



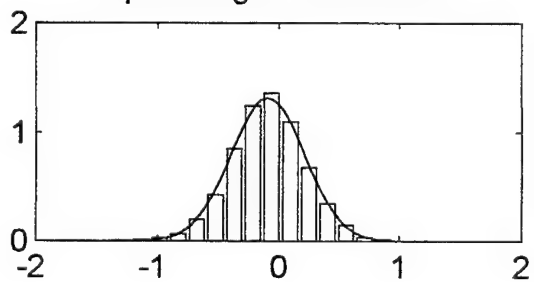
Optical signal, 3 Jun 96, 1551 hr

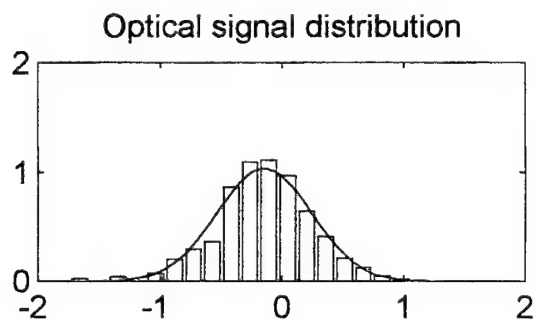
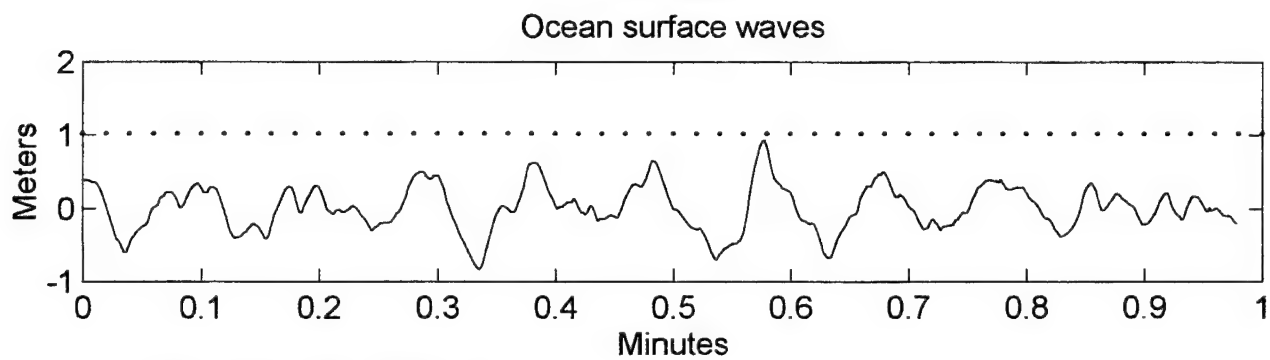
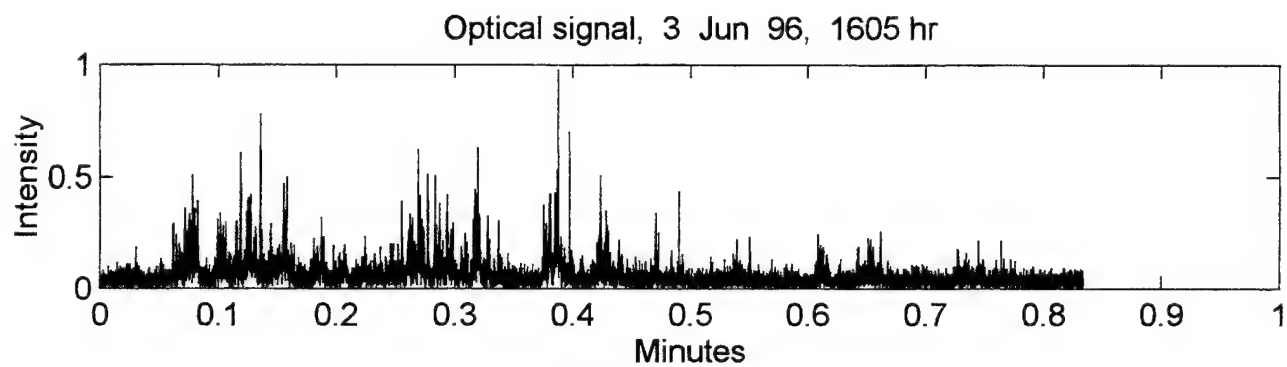


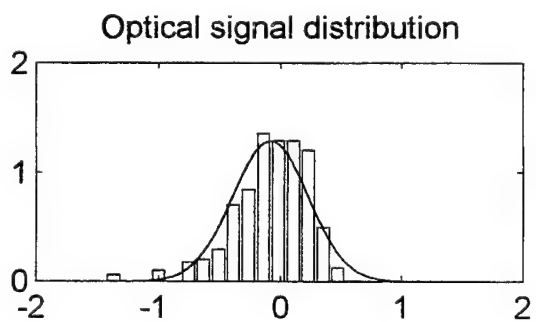
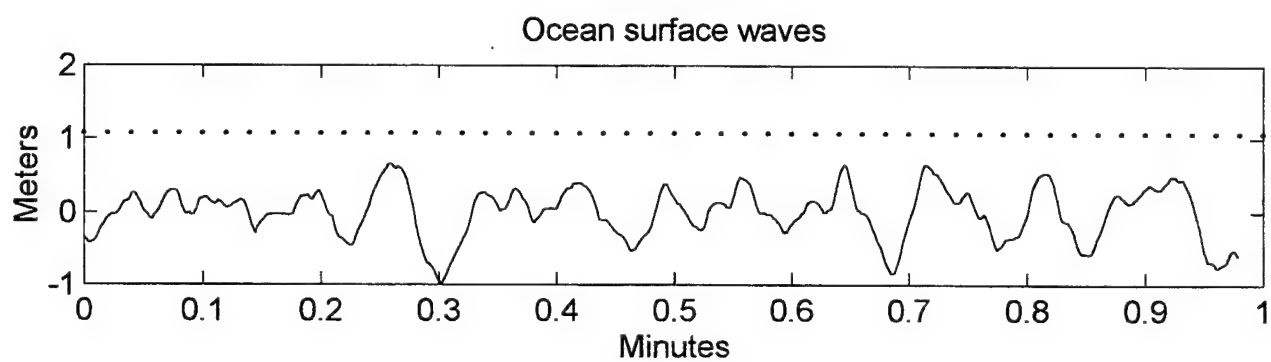
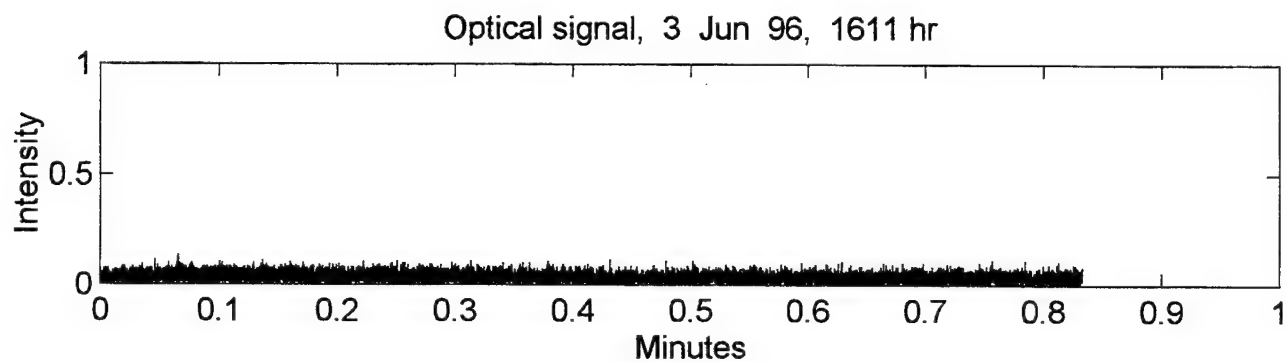
Ocean surface waves



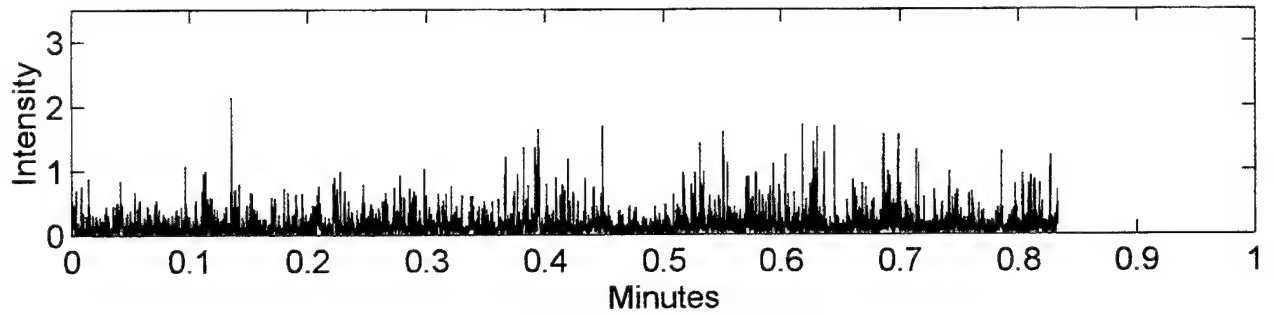
Optical signal distribution



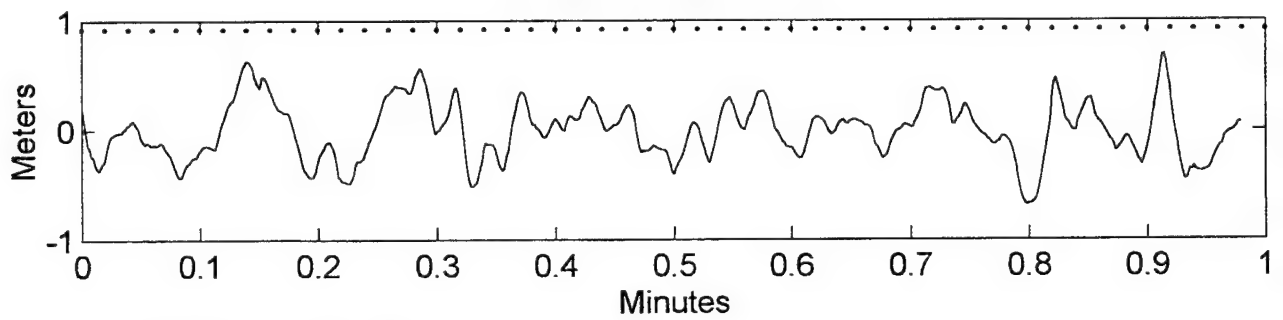




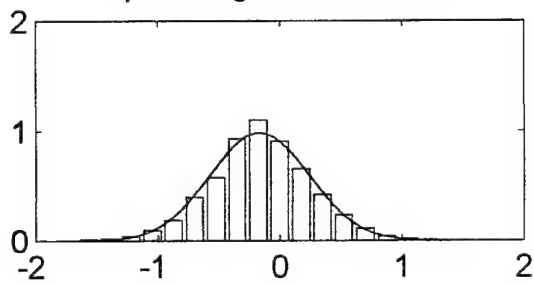
Optical signal, 4 Jun 96, 1325 hr



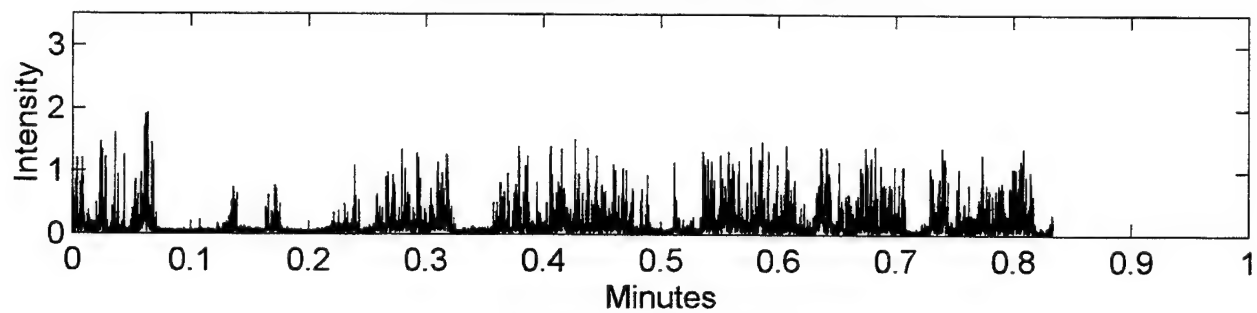
Ocean surface waves



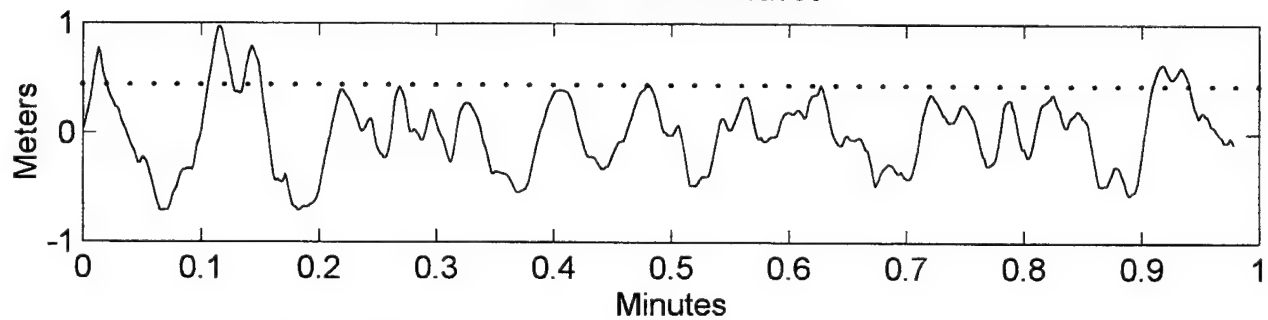
Optical signal distribution



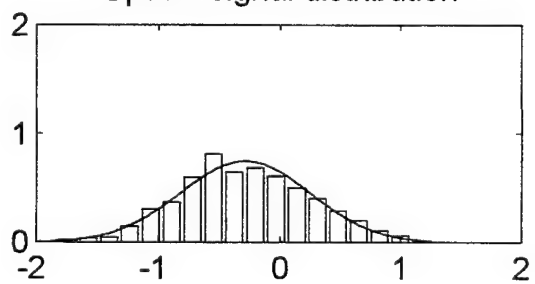
Optical signal, 4 Jun 96, 1417 hr

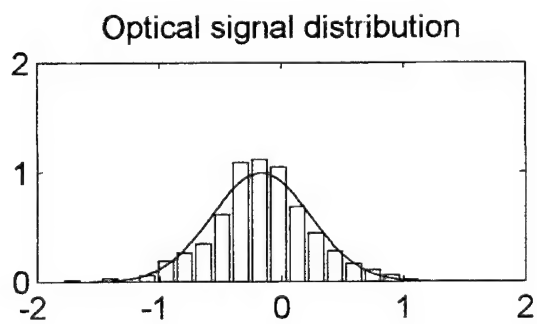
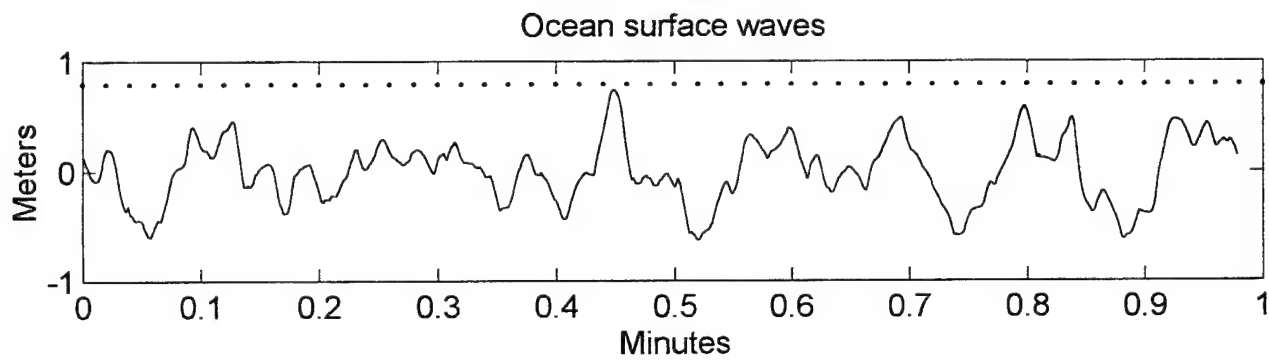
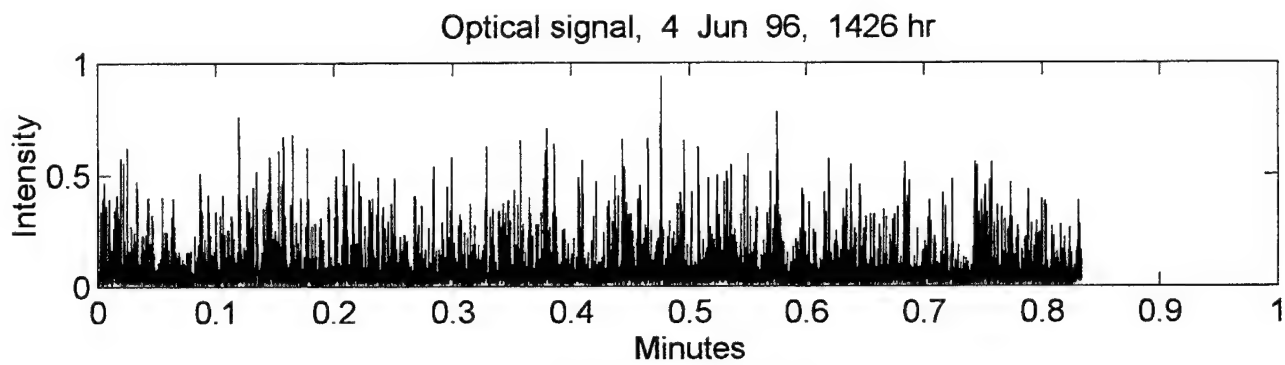


Ocean surface waves

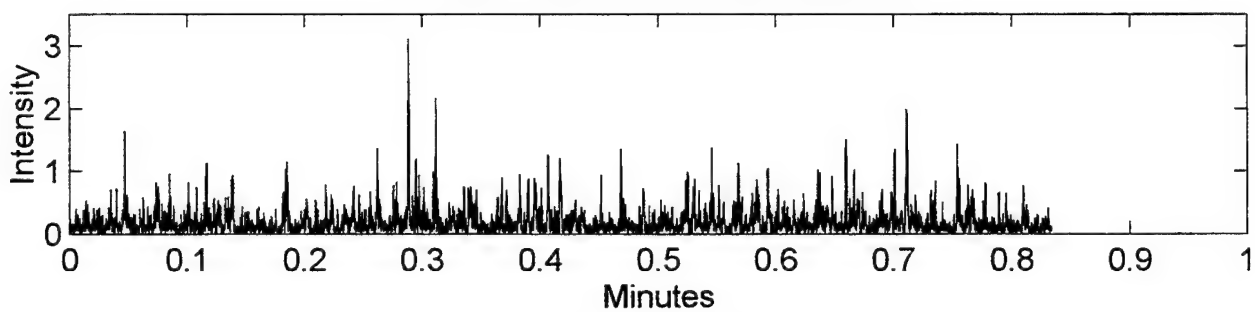


Optical signal distribution

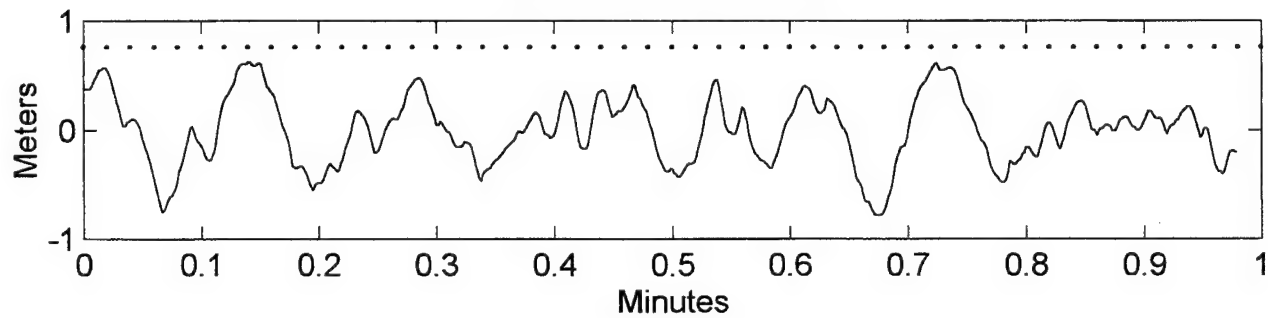




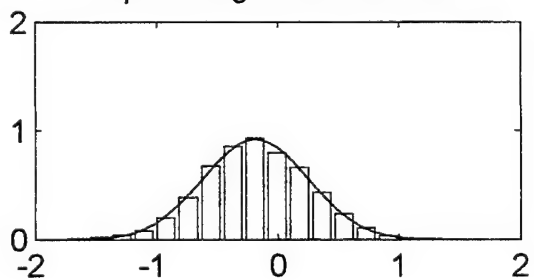
Optical signal, 5 Jun 96, 1933 hr



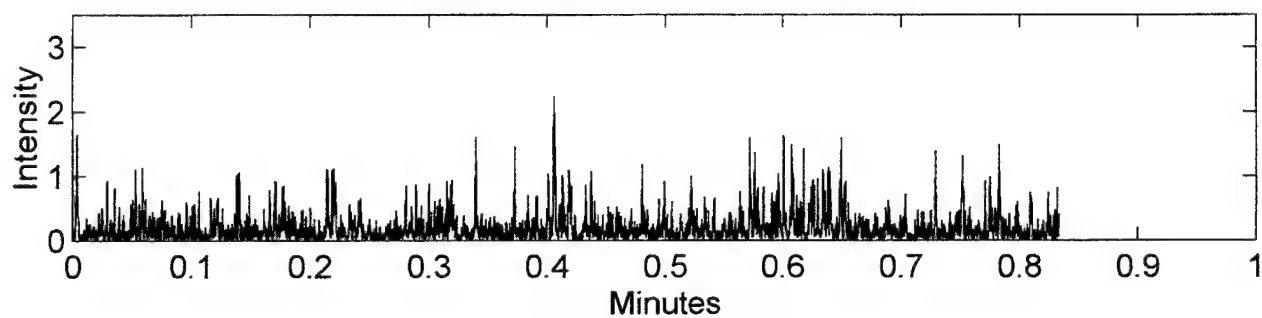
Ocean surface waves



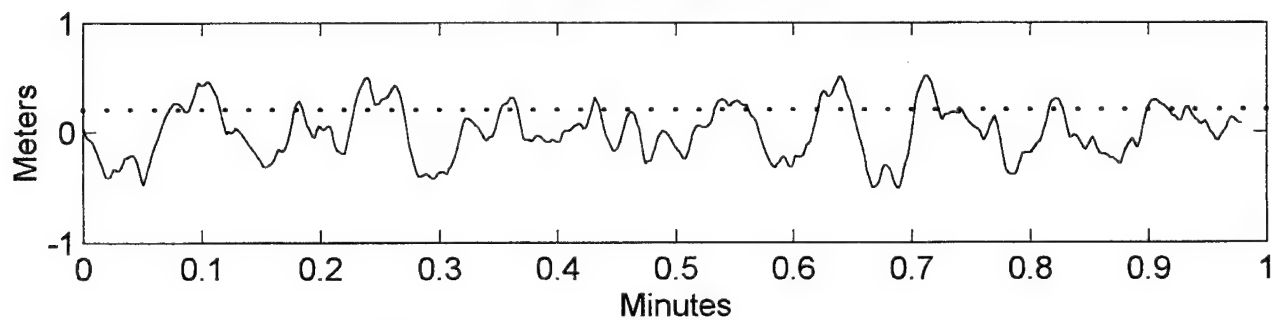
Optical signal distribution



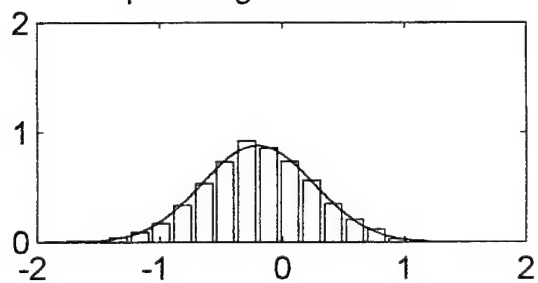
Optical signal, 5 Jun 96, 1945 hr

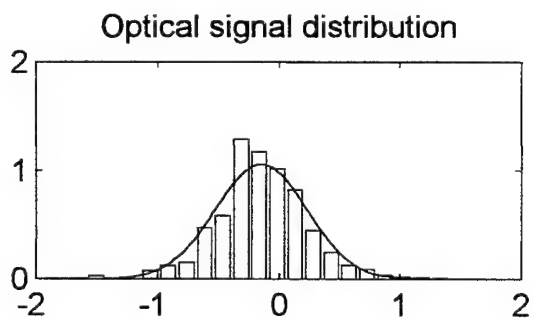
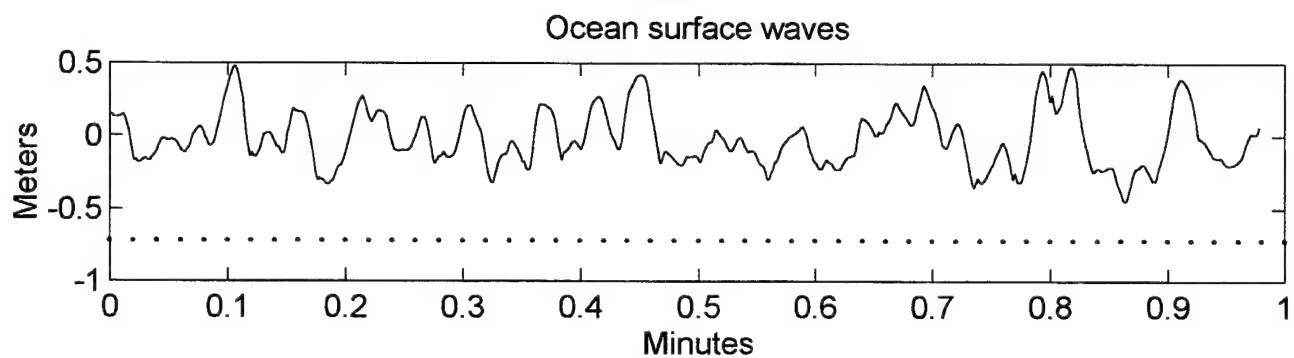
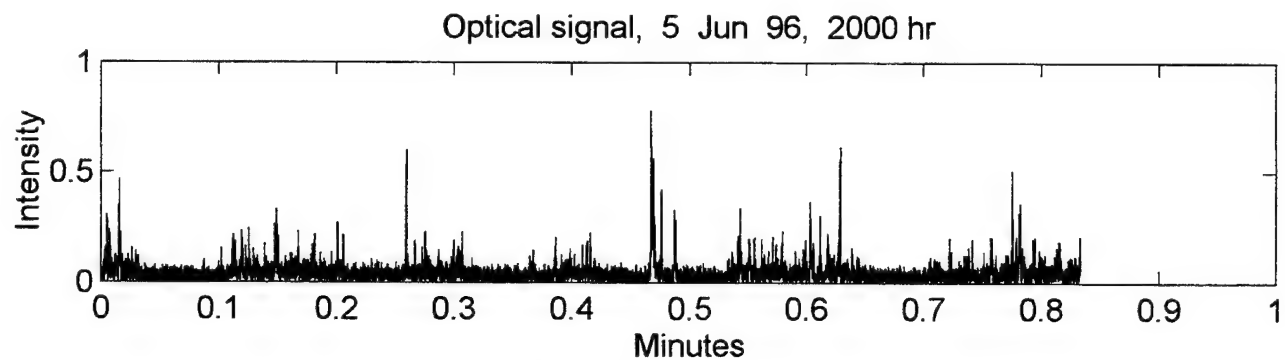


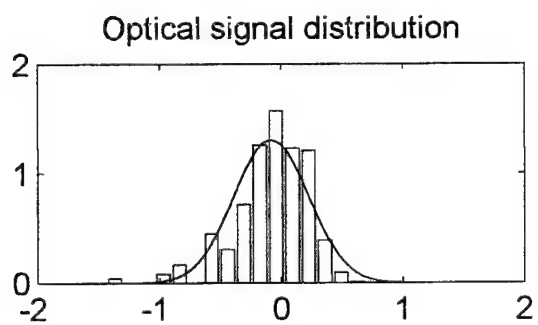
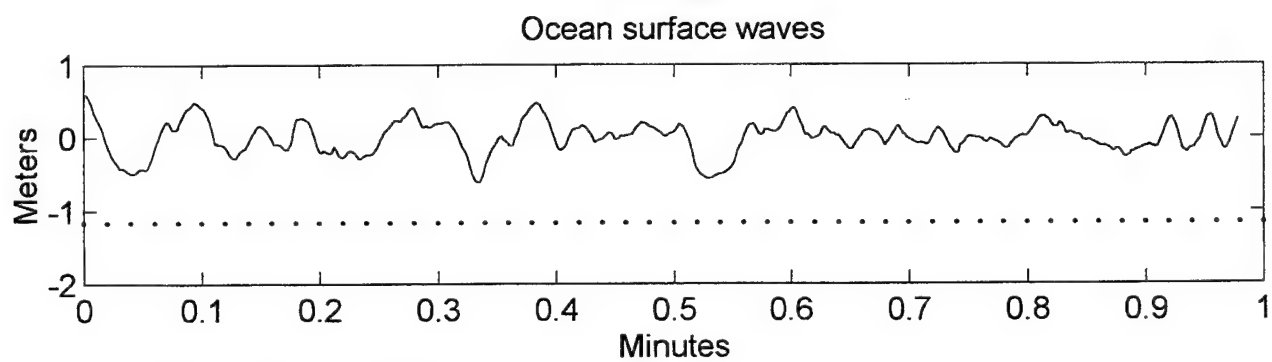
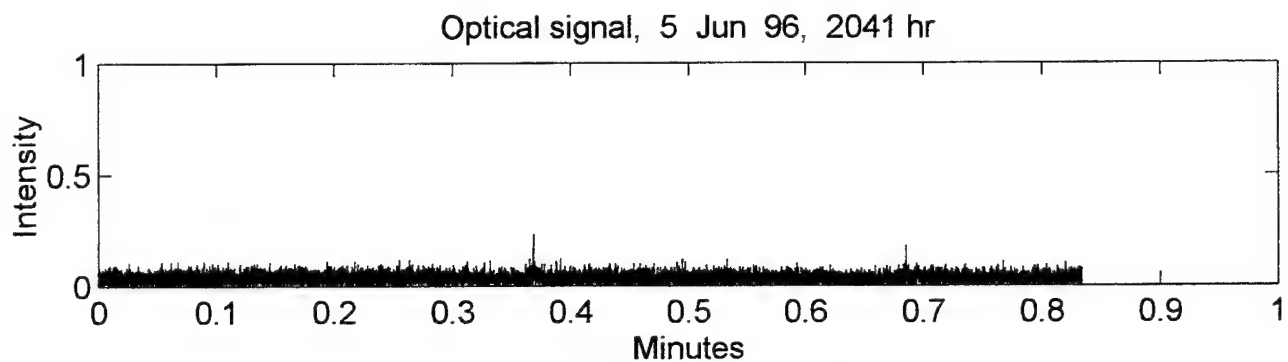
Ocean surface waves



Optical signal distribution

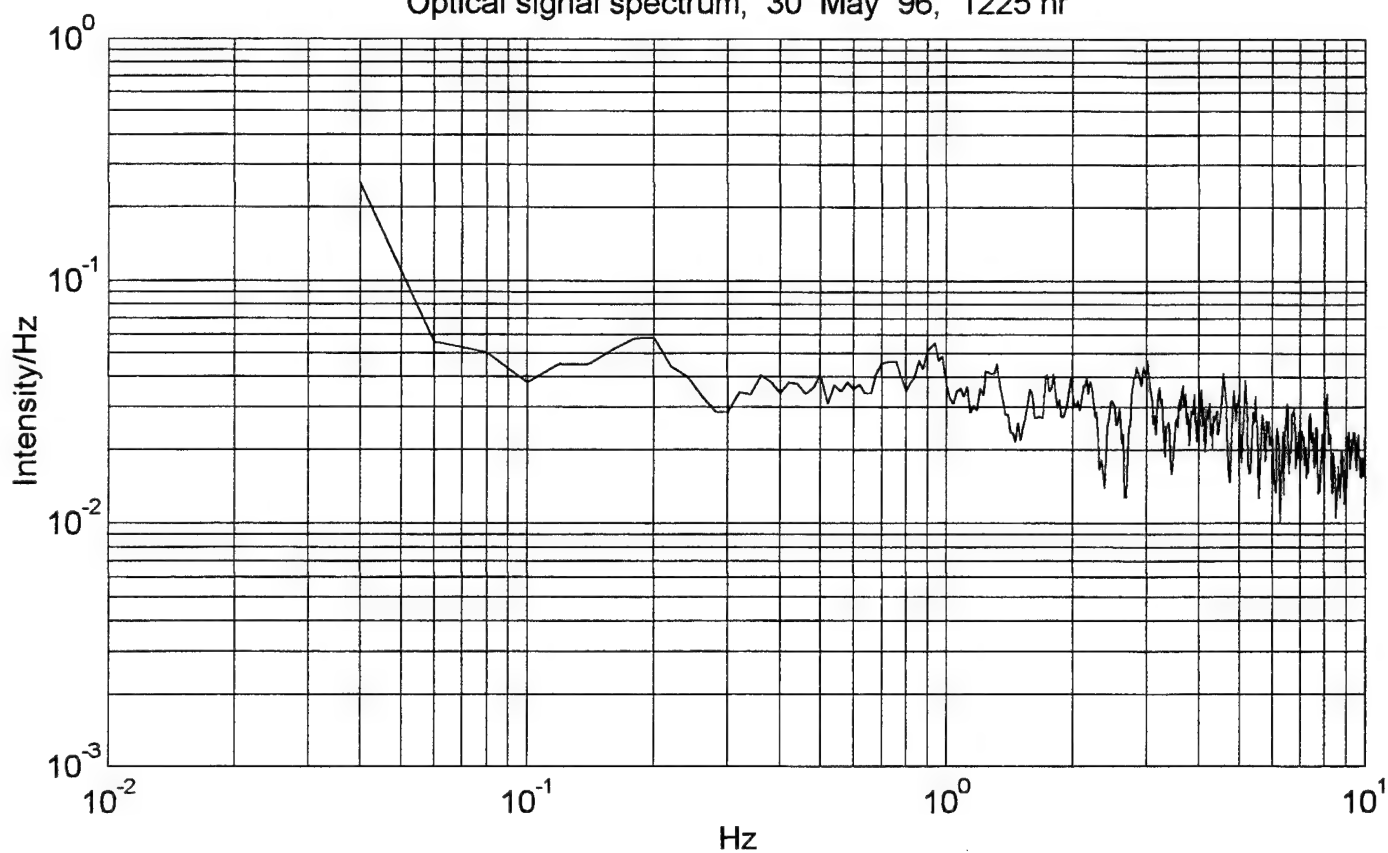




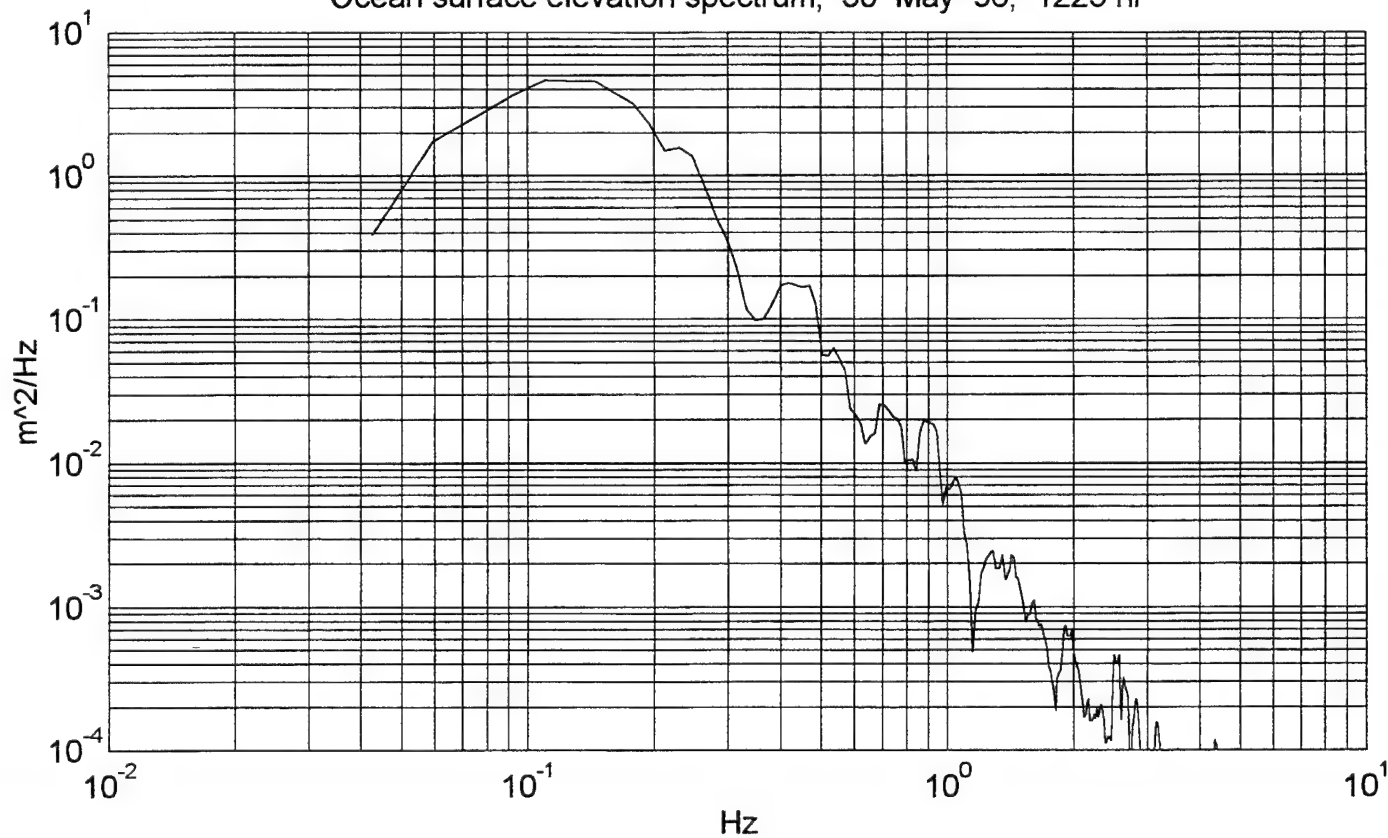


III. OPTICAL SIGNAL SPECTRUM AND THE CORRESPONDING OCEAN SURFACE ELEVATION SPECTRUM

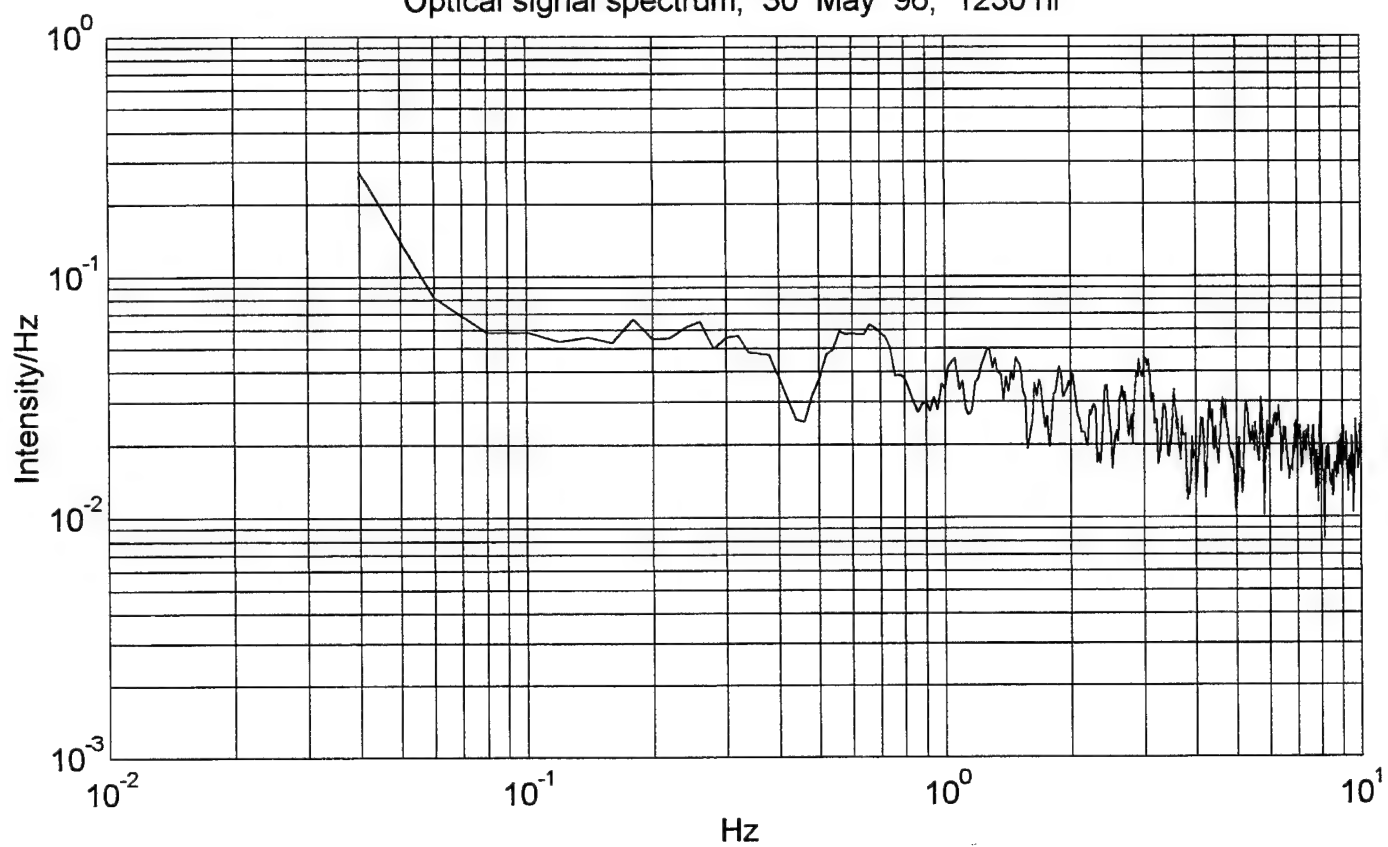
Optical signal spectrum, 30 May 96, 1225 hr



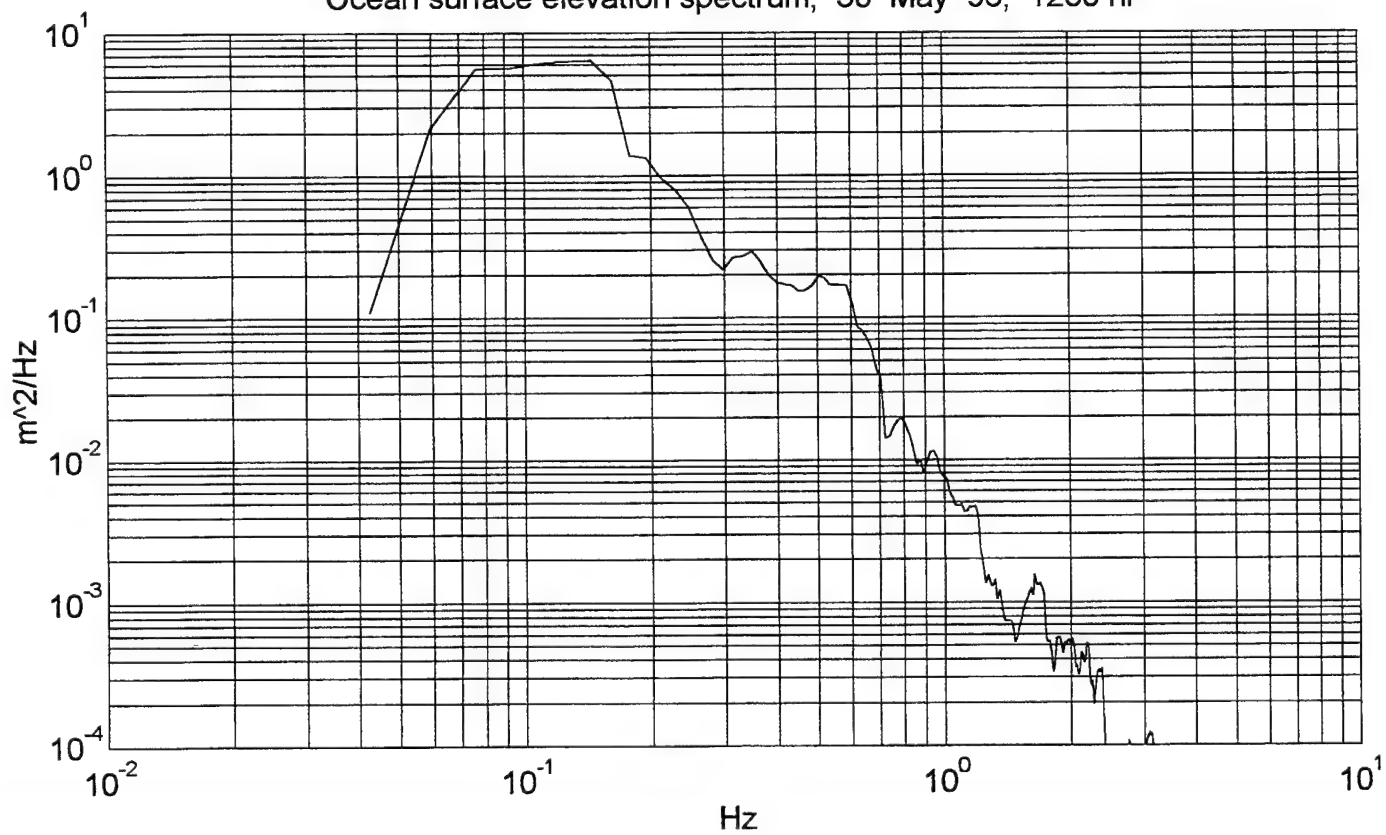
Ocean surface elevation spectrum, 30 May 96, 1225 hr



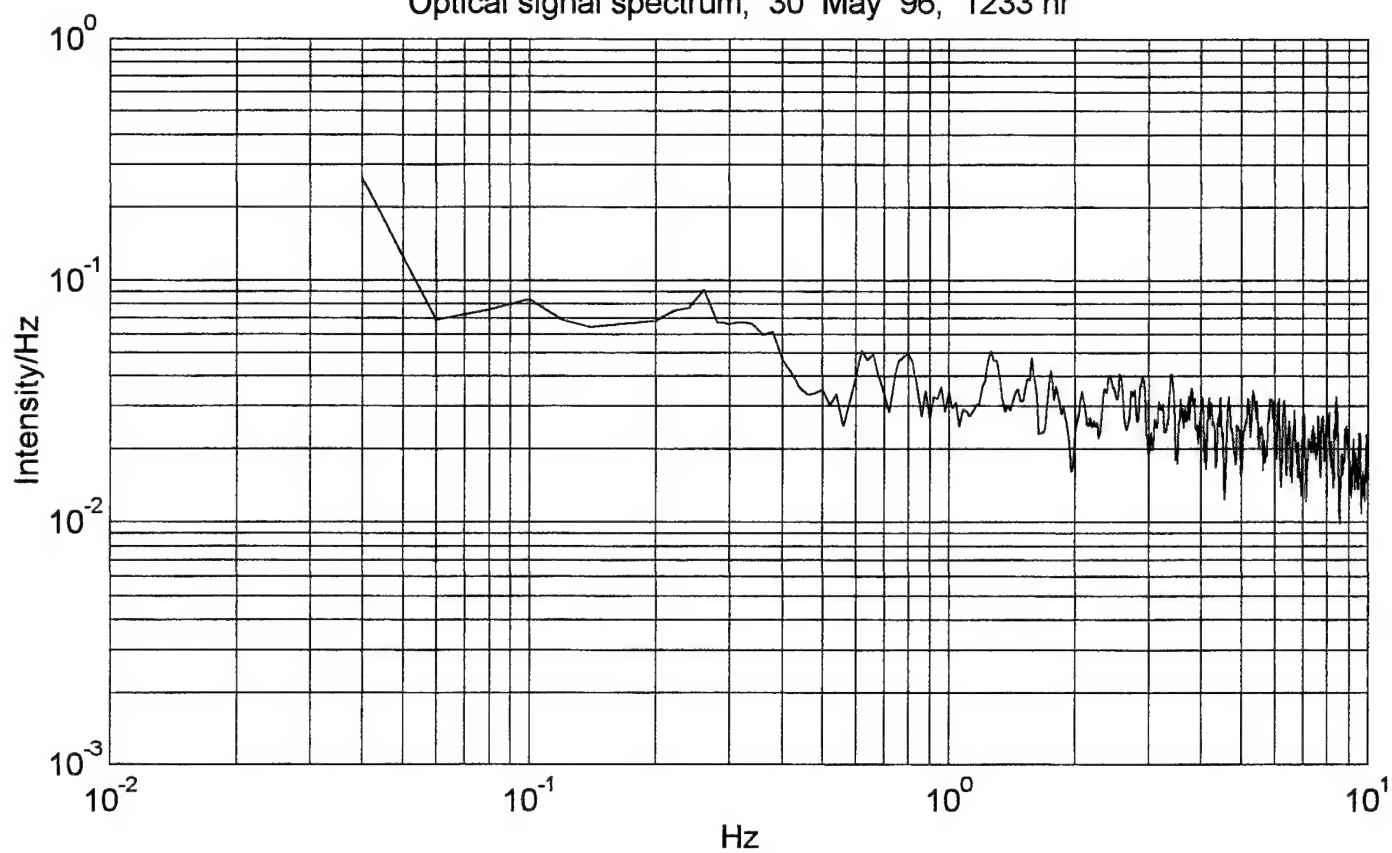
Optical signal spectrum, 30 May 96, 1230 hr



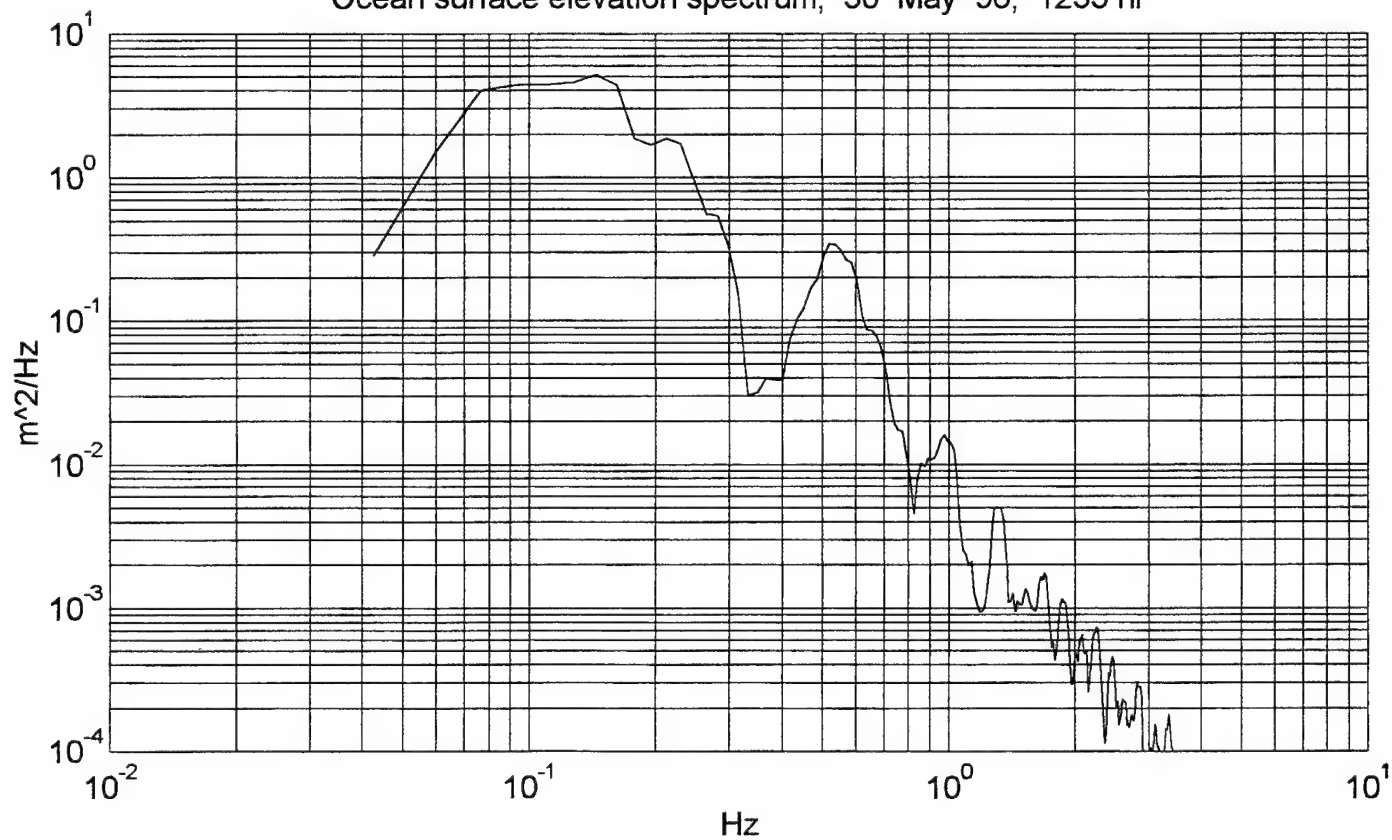
Ocean surface elevation spectrum, 30 May 96, 1230 hr



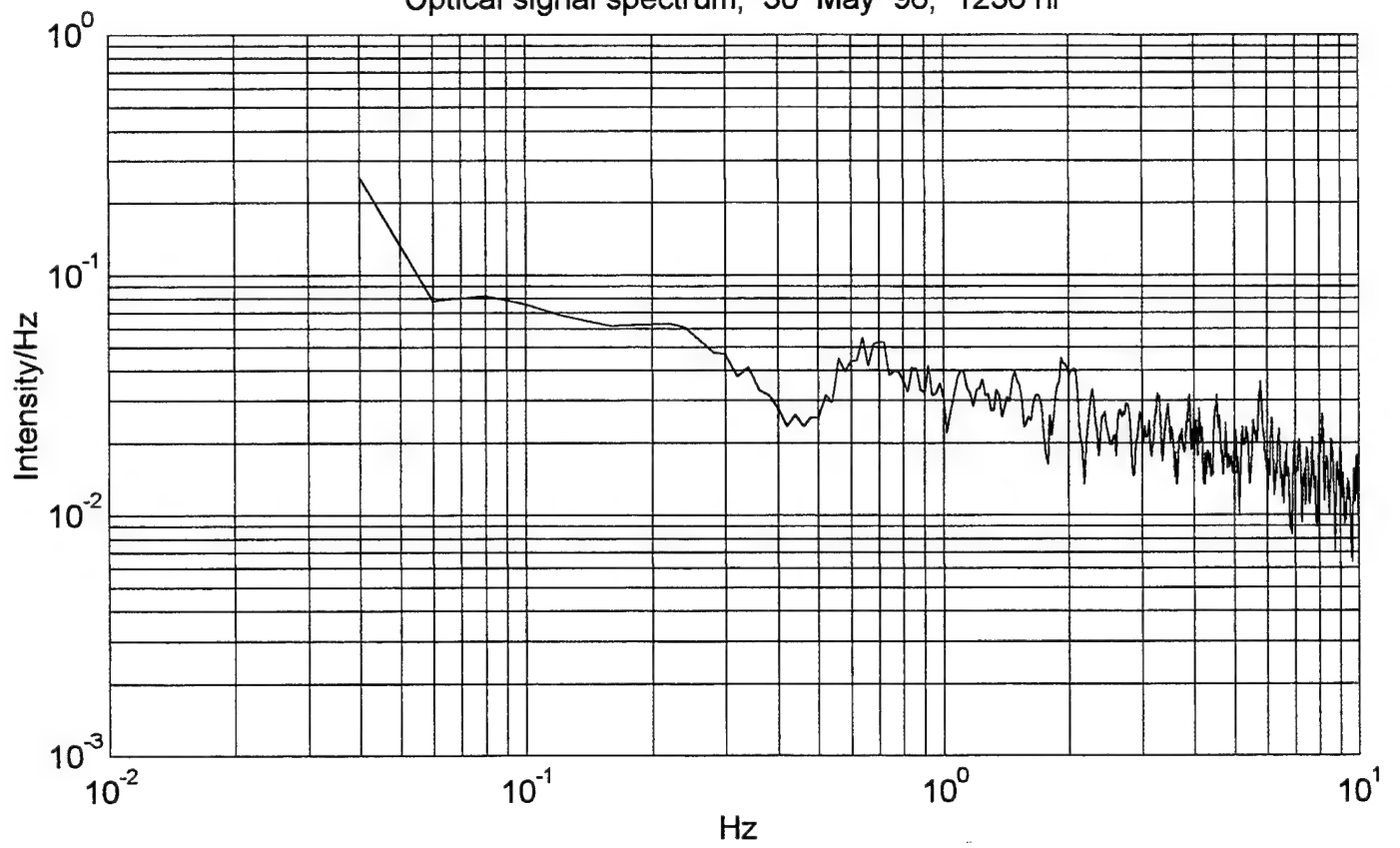
Optical signal spectrum, 30 May 96, 1233 hr



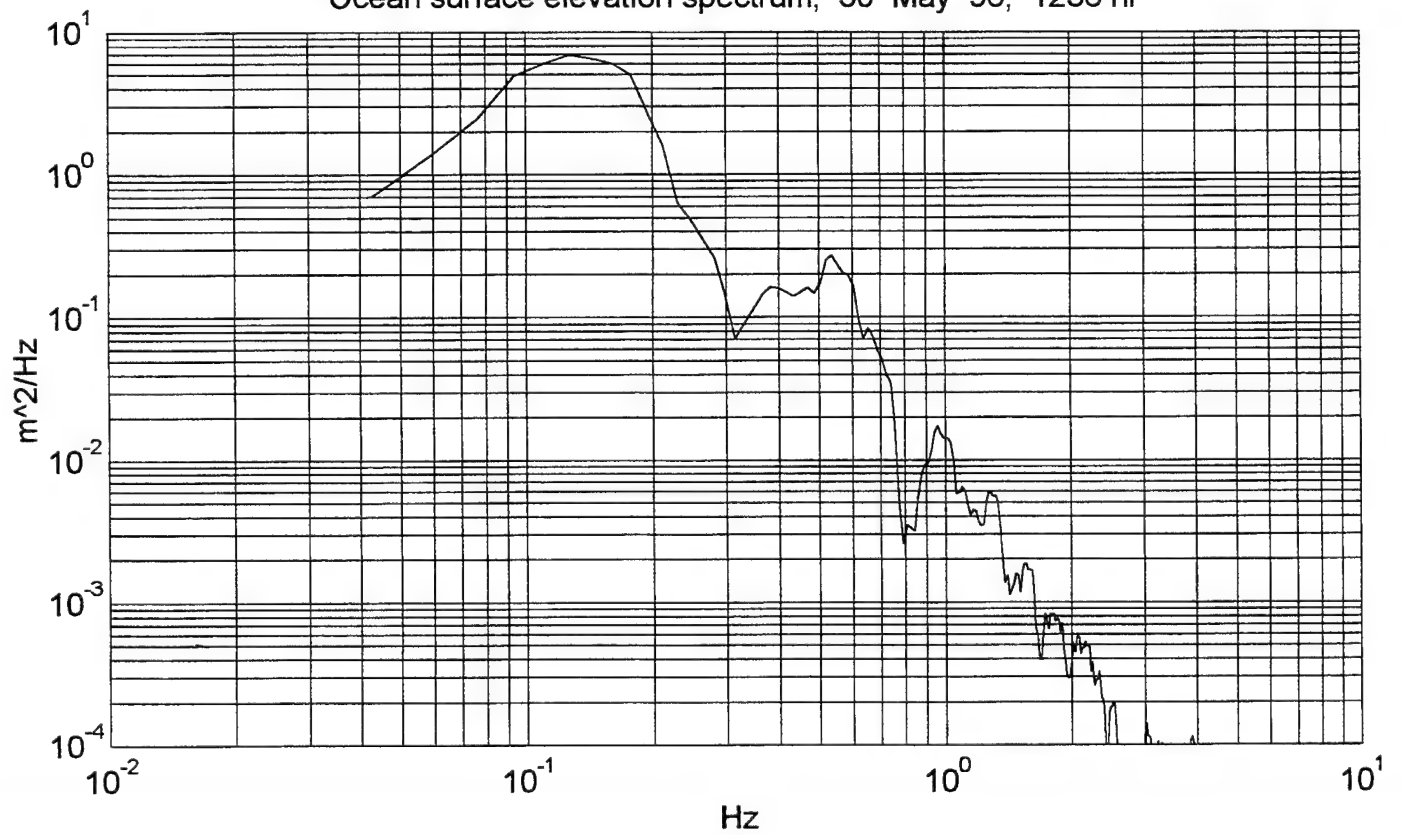
Ocean surface elevation spectrum, 30 May 96, 1233 hr



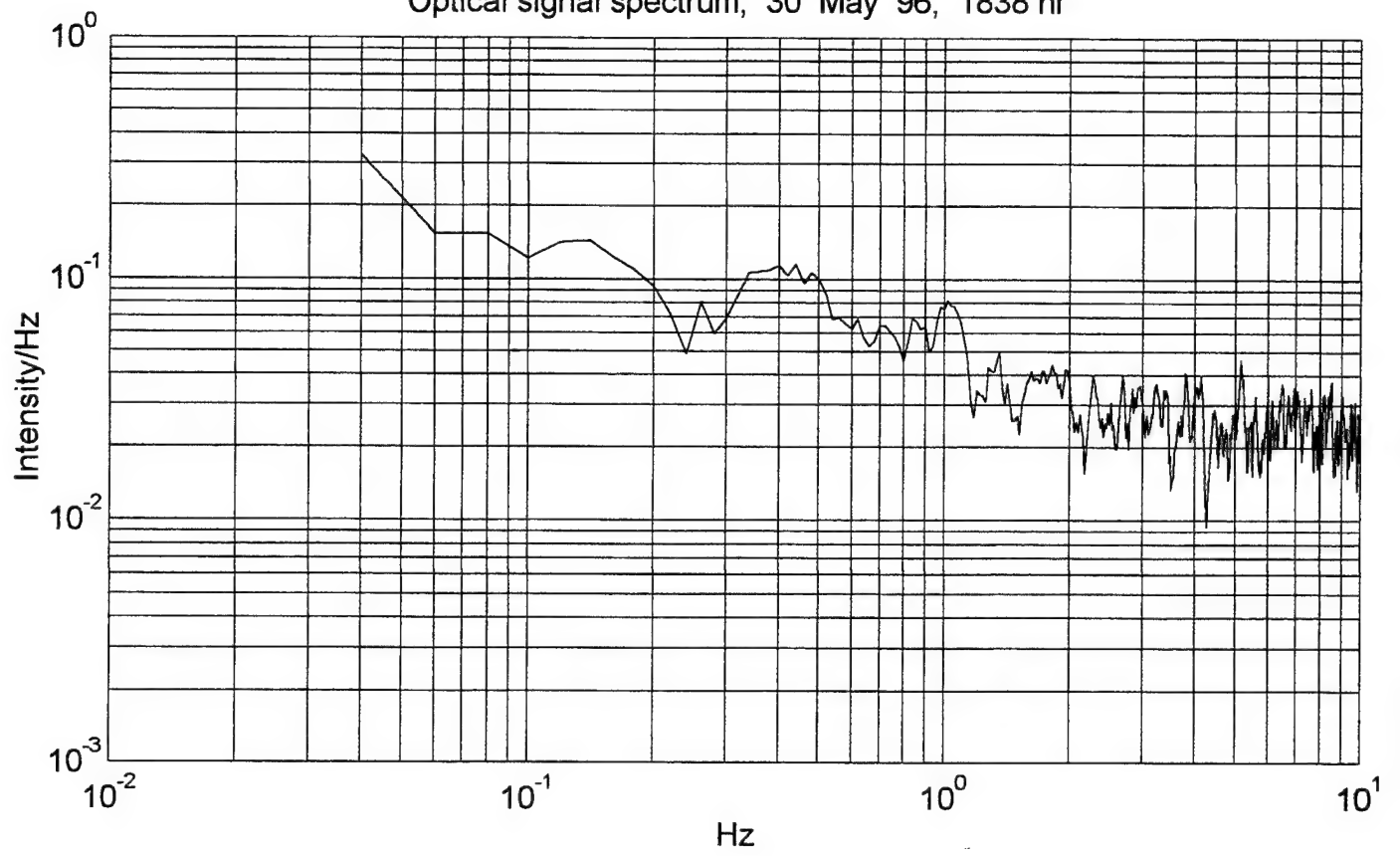
Optical signal spectrum, 30 May 96, 1236 hr



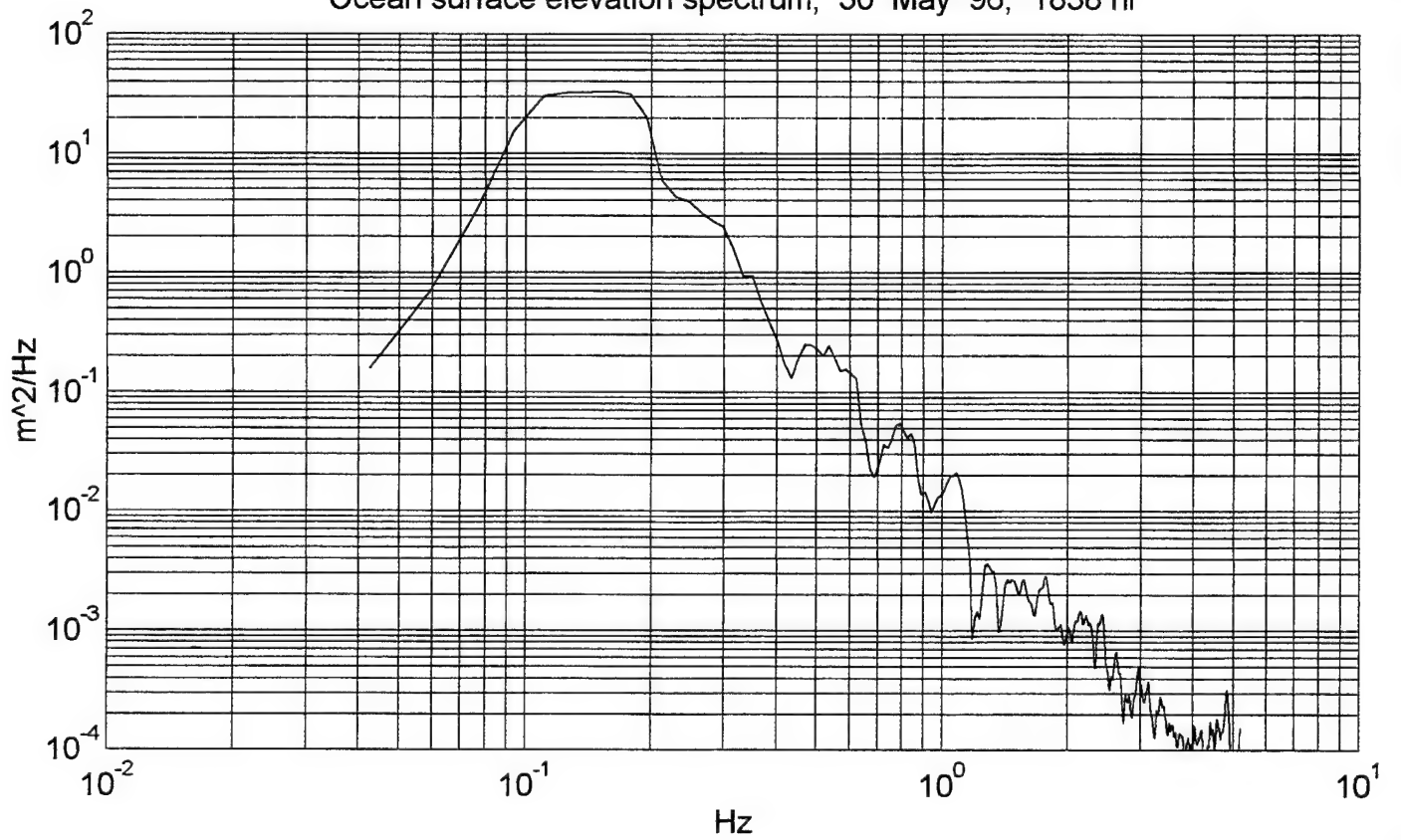
Ocean surface elevation spectrum, 30 May 96, 1236 hr



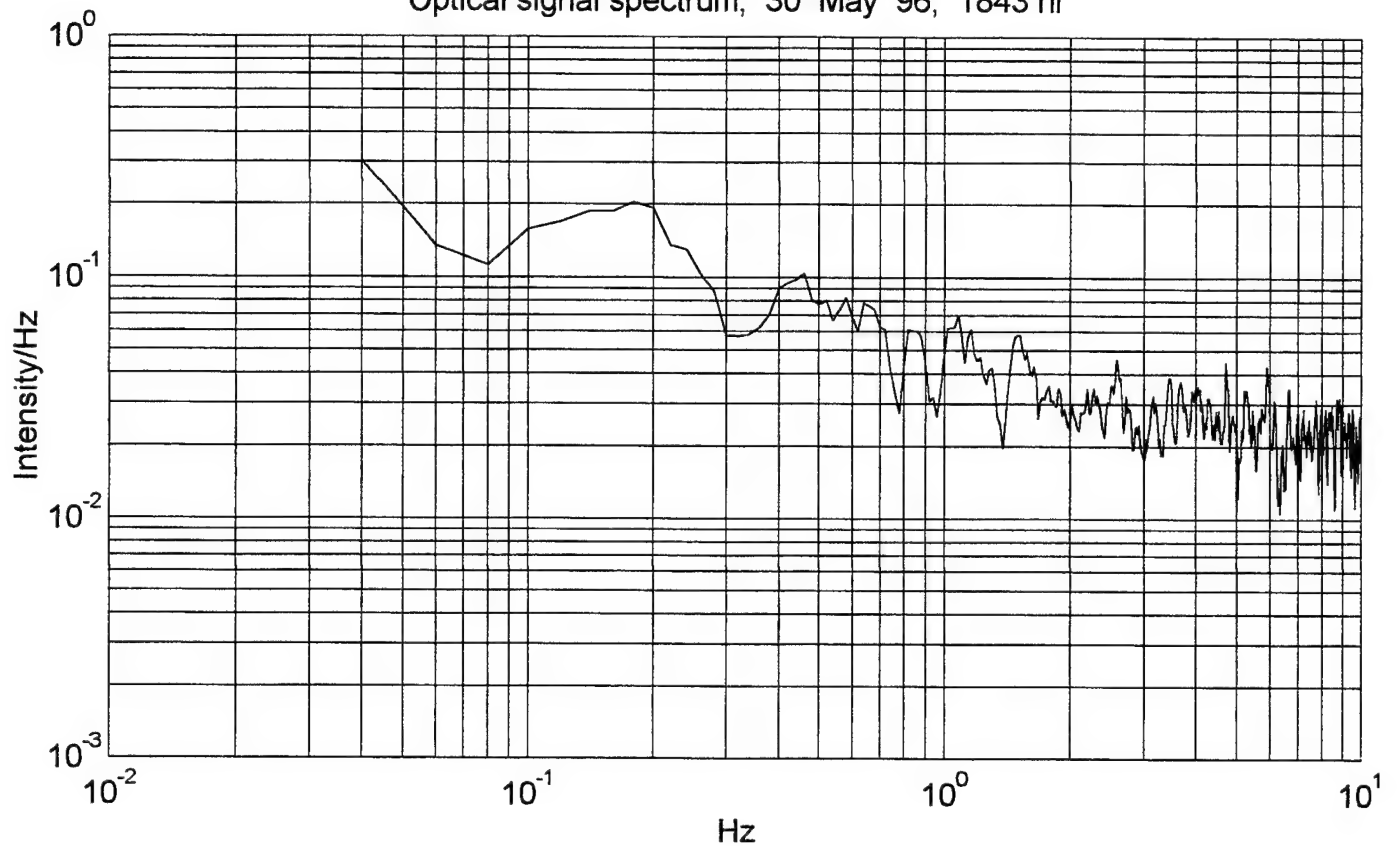
Optical signal spectrum, 30 May 96, 1838 hr



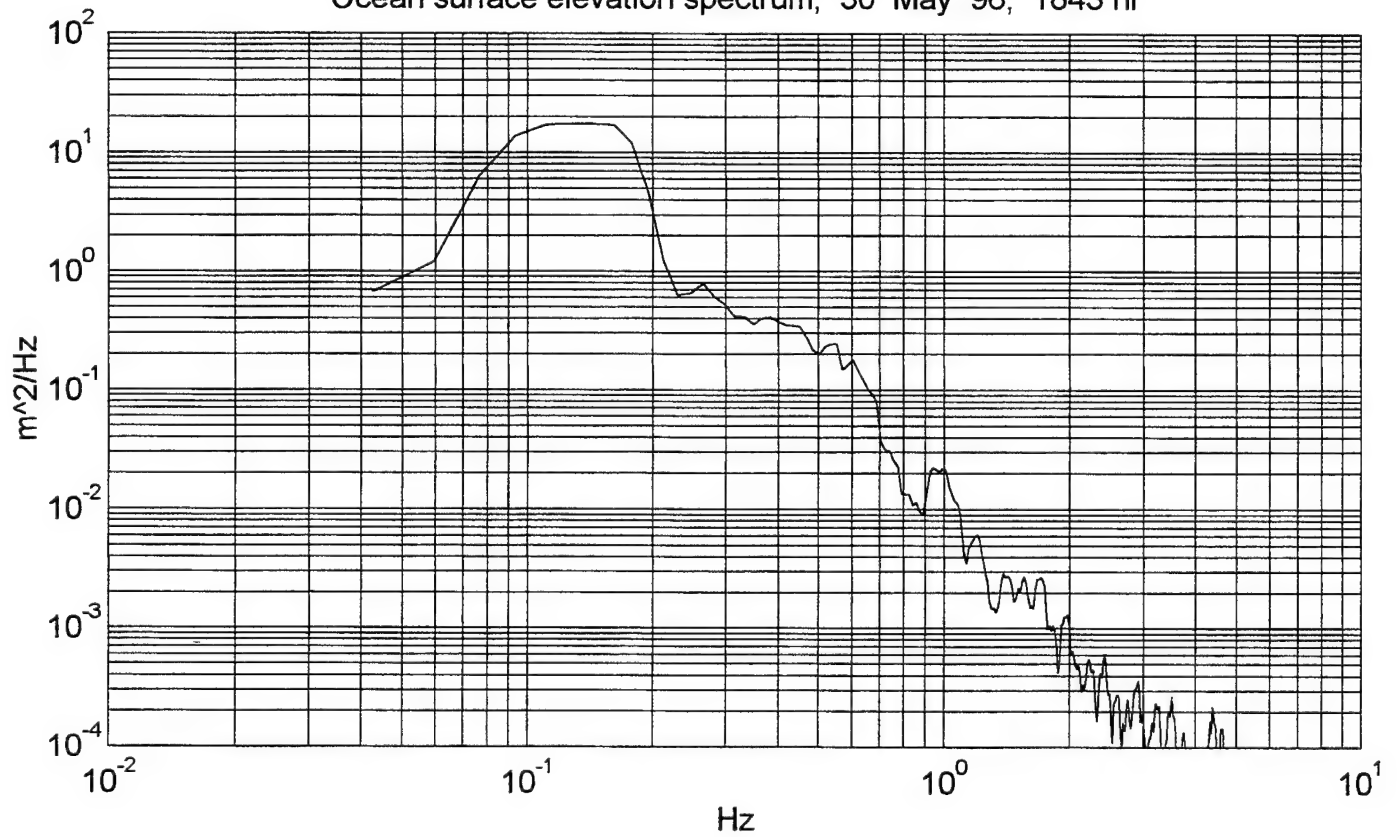
Ocean surface elevation spectrum, 30 May 96, 1838 hr



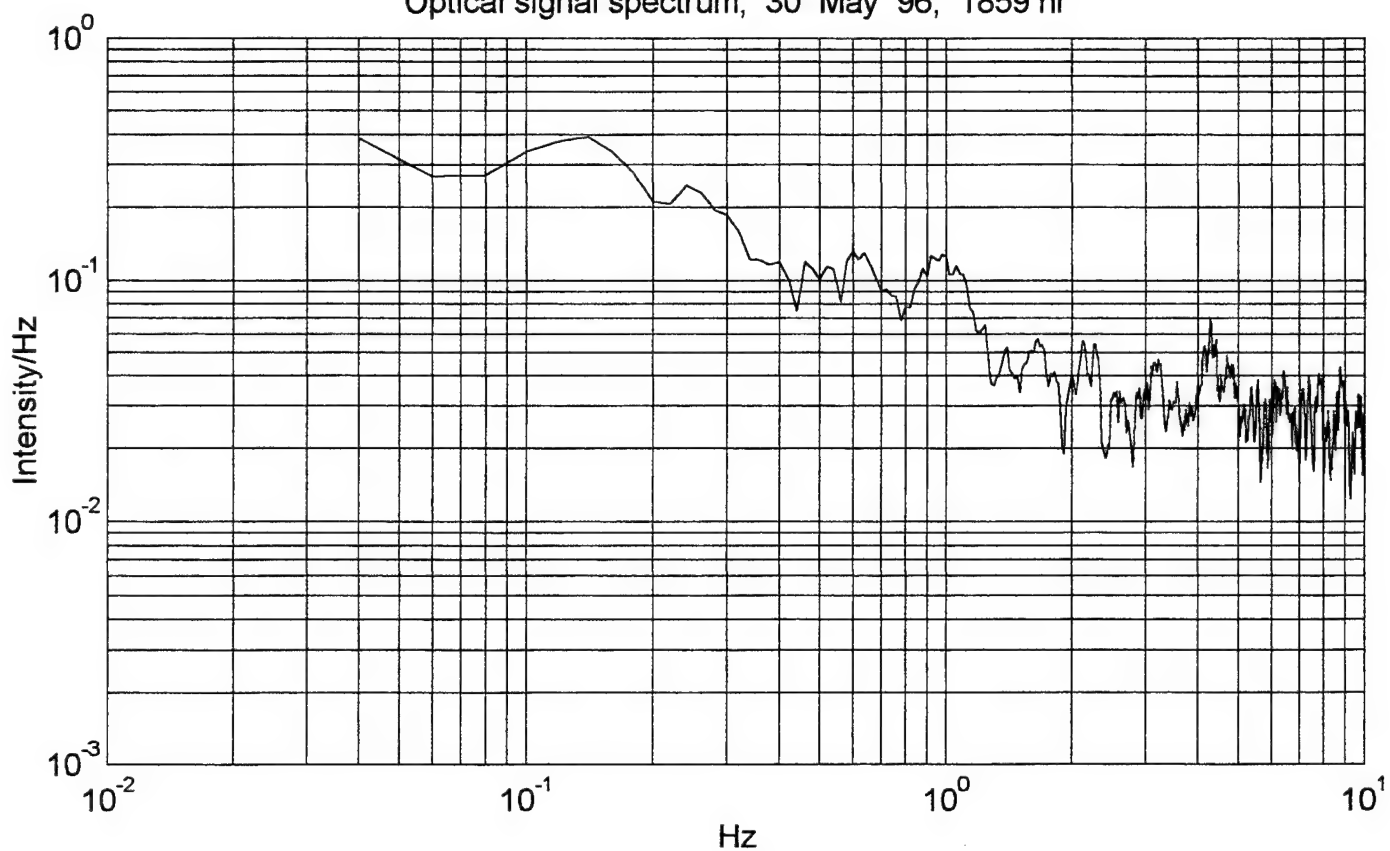
Optical signal spectrum, 30 May 96, 1843 hr



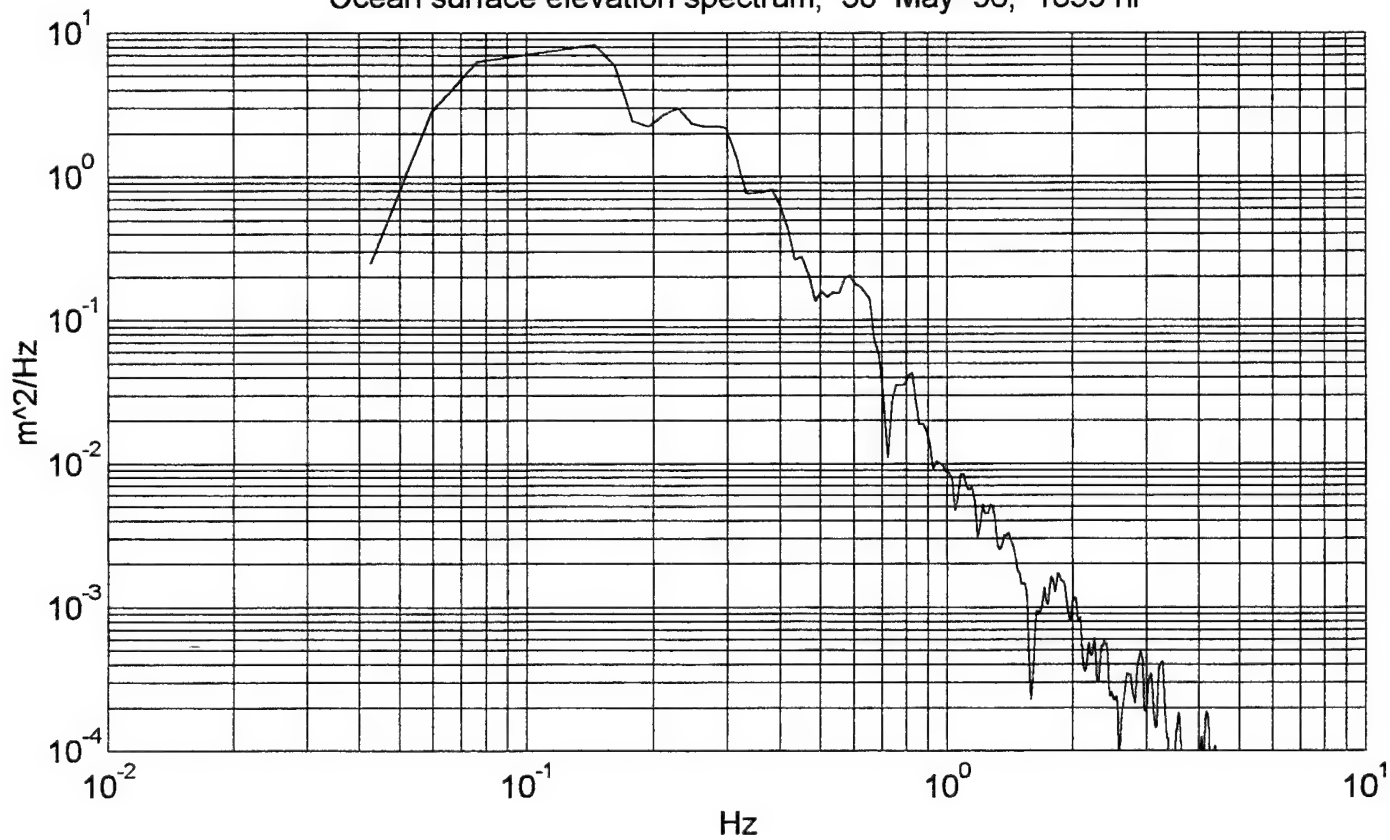
Ocean surface elevation spectrum, 30 May 96, 1843 hr



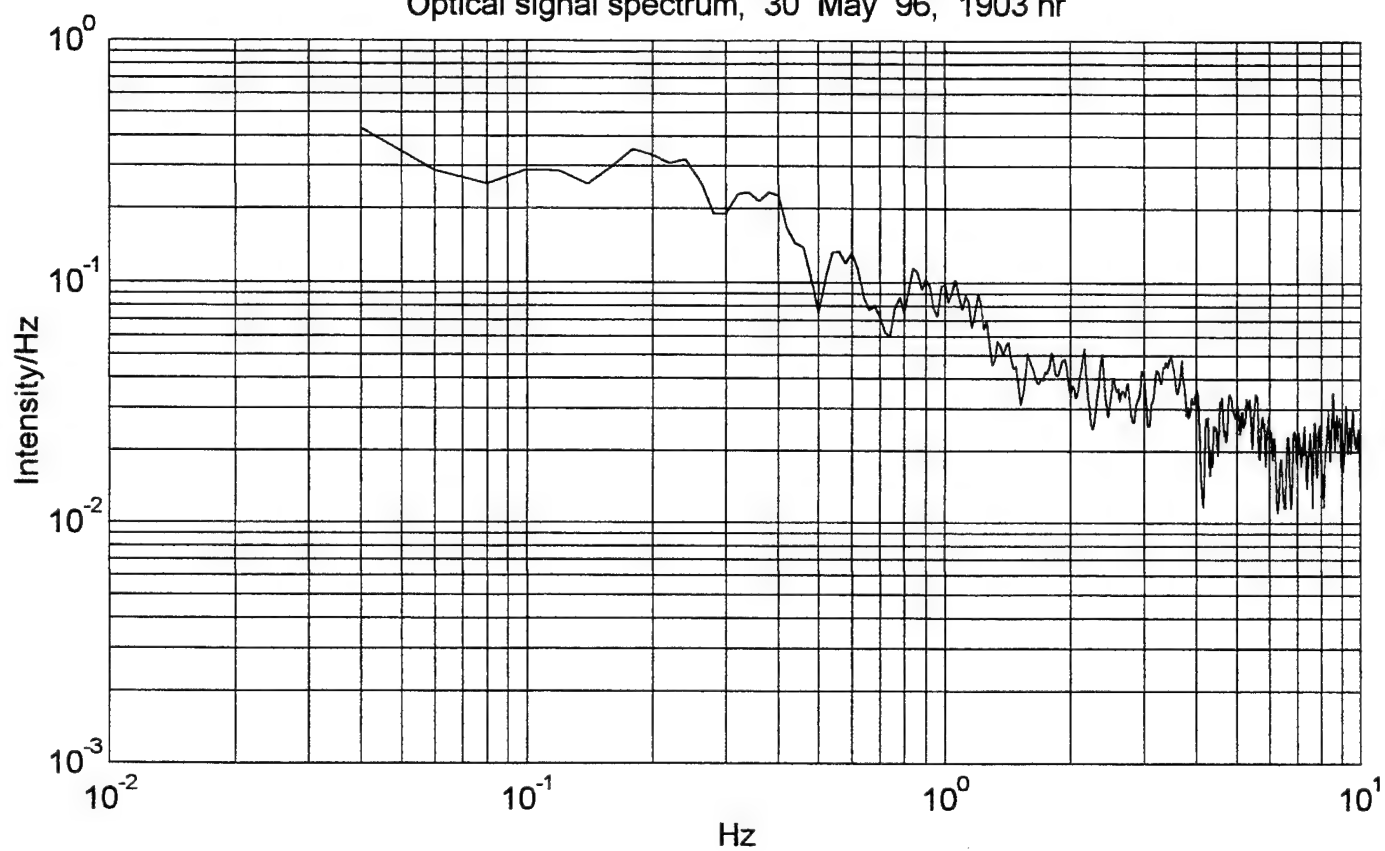
Optical signal spectrum, 30 May 96, 1859 hr



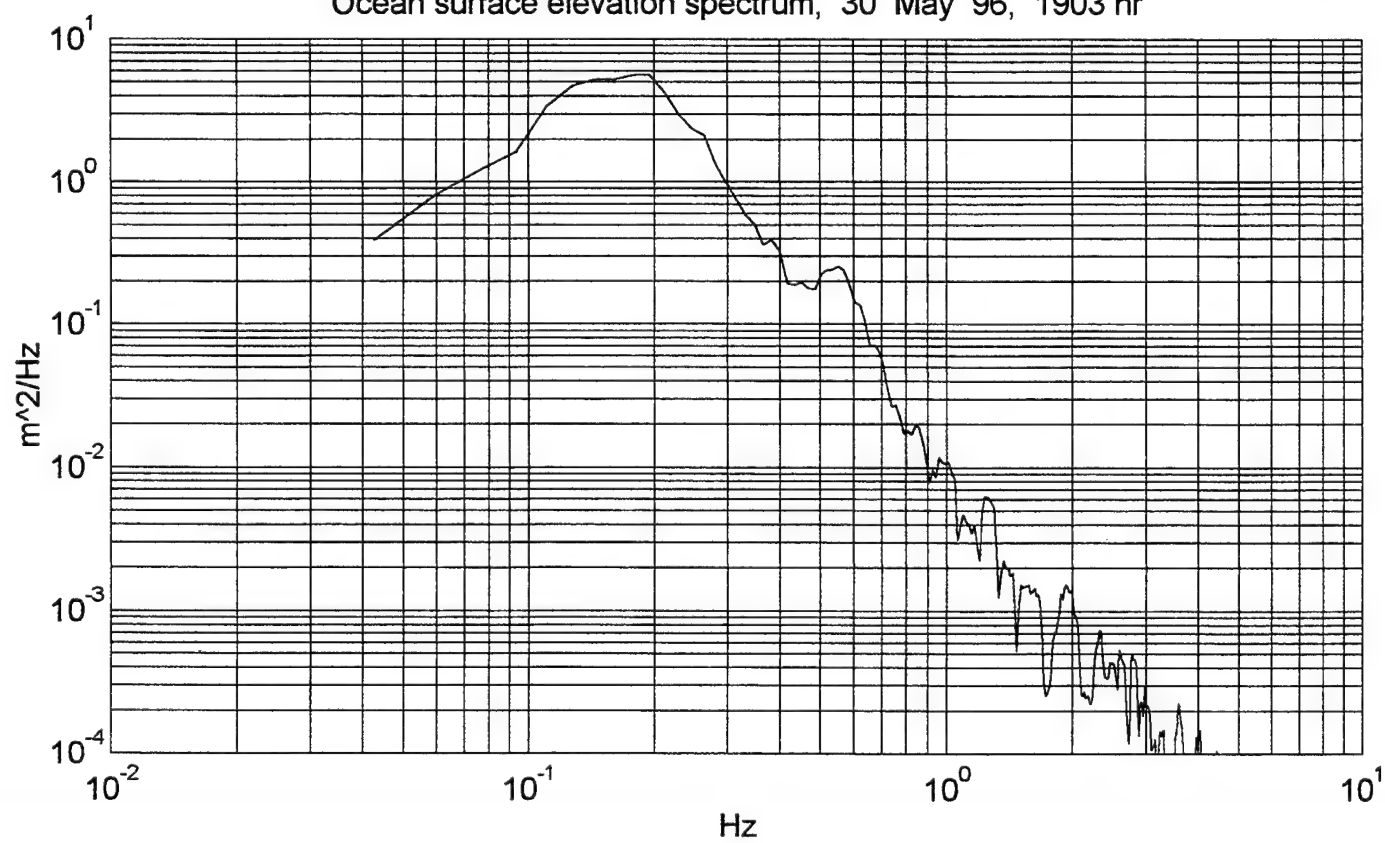
Ocean surface elevation spectrum, 30 May 96, 1859 hr



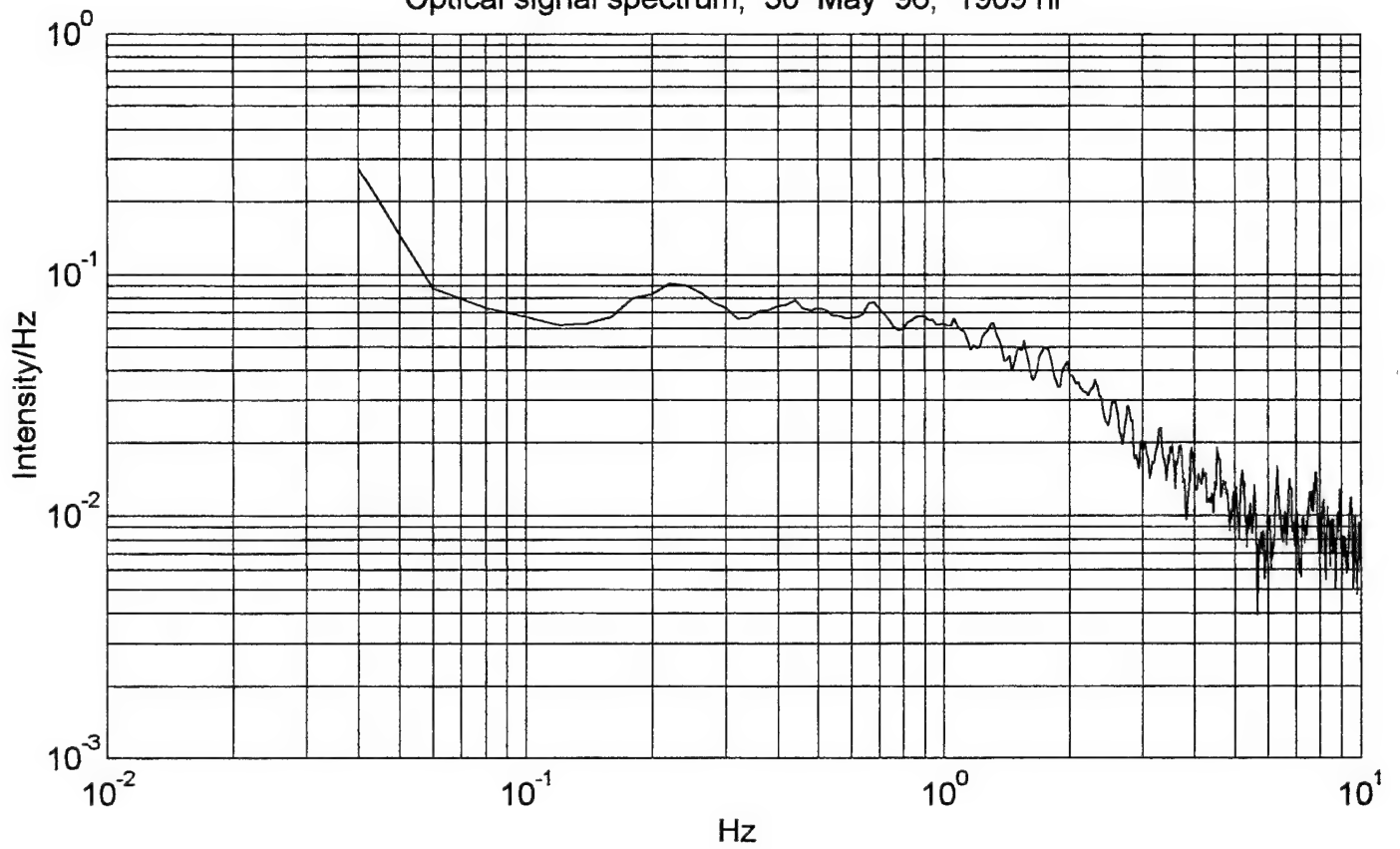
Optical signal spectrum, 30 May 96, 1903 hr



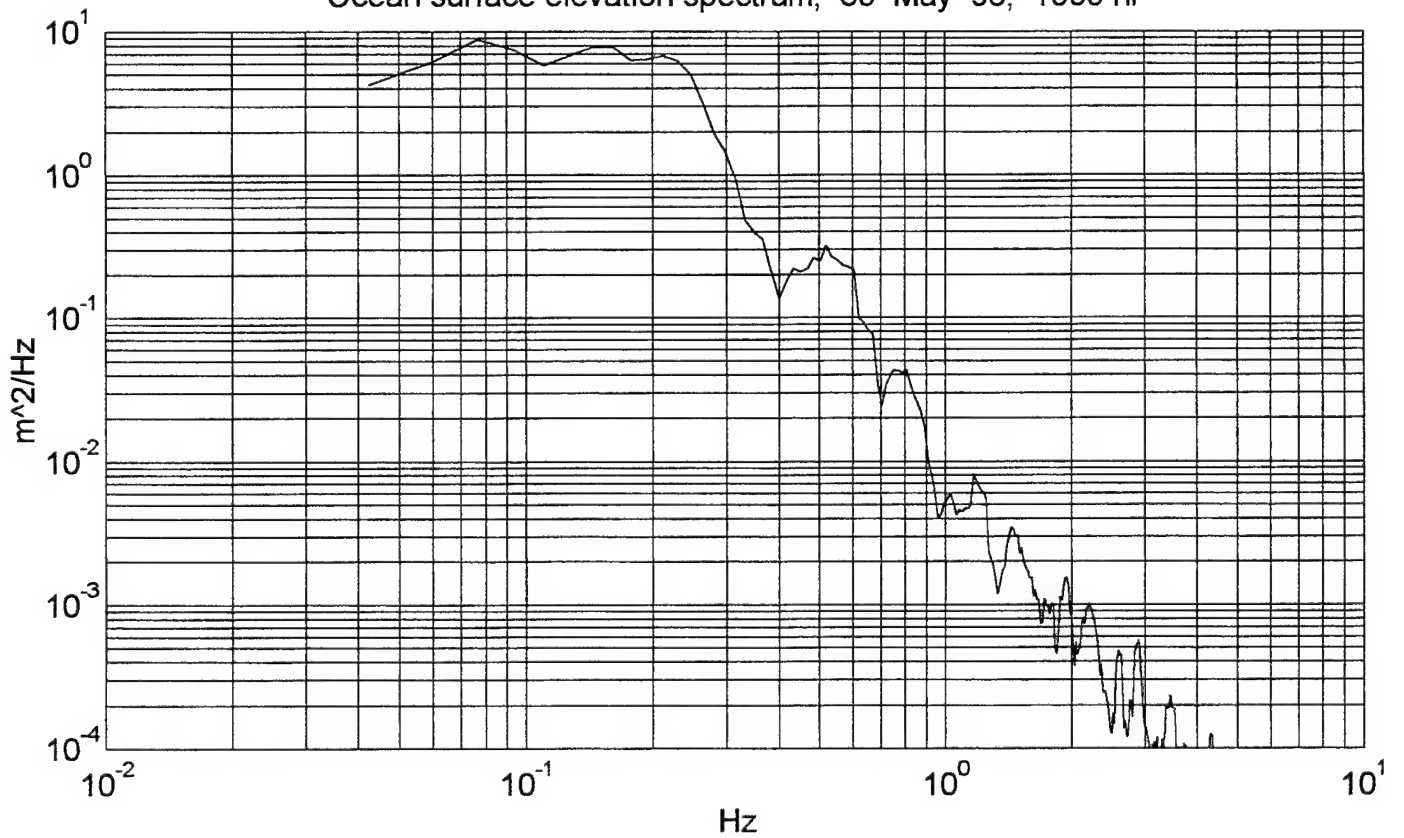
Ocean surface elevation spectrum, 30 May 96, 1903 hr



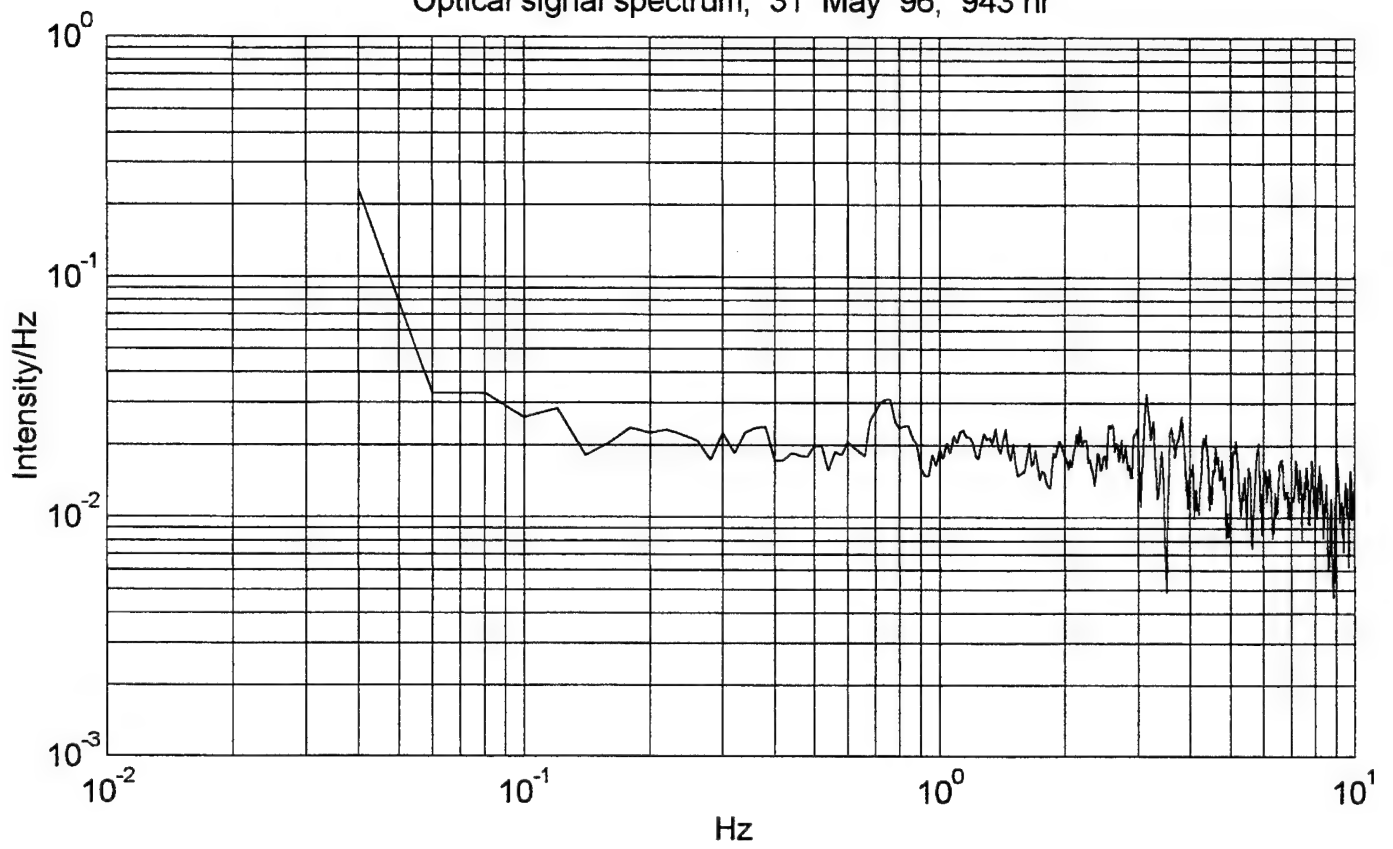
Optical signal spectrum, 30 May 96, 1909 hr



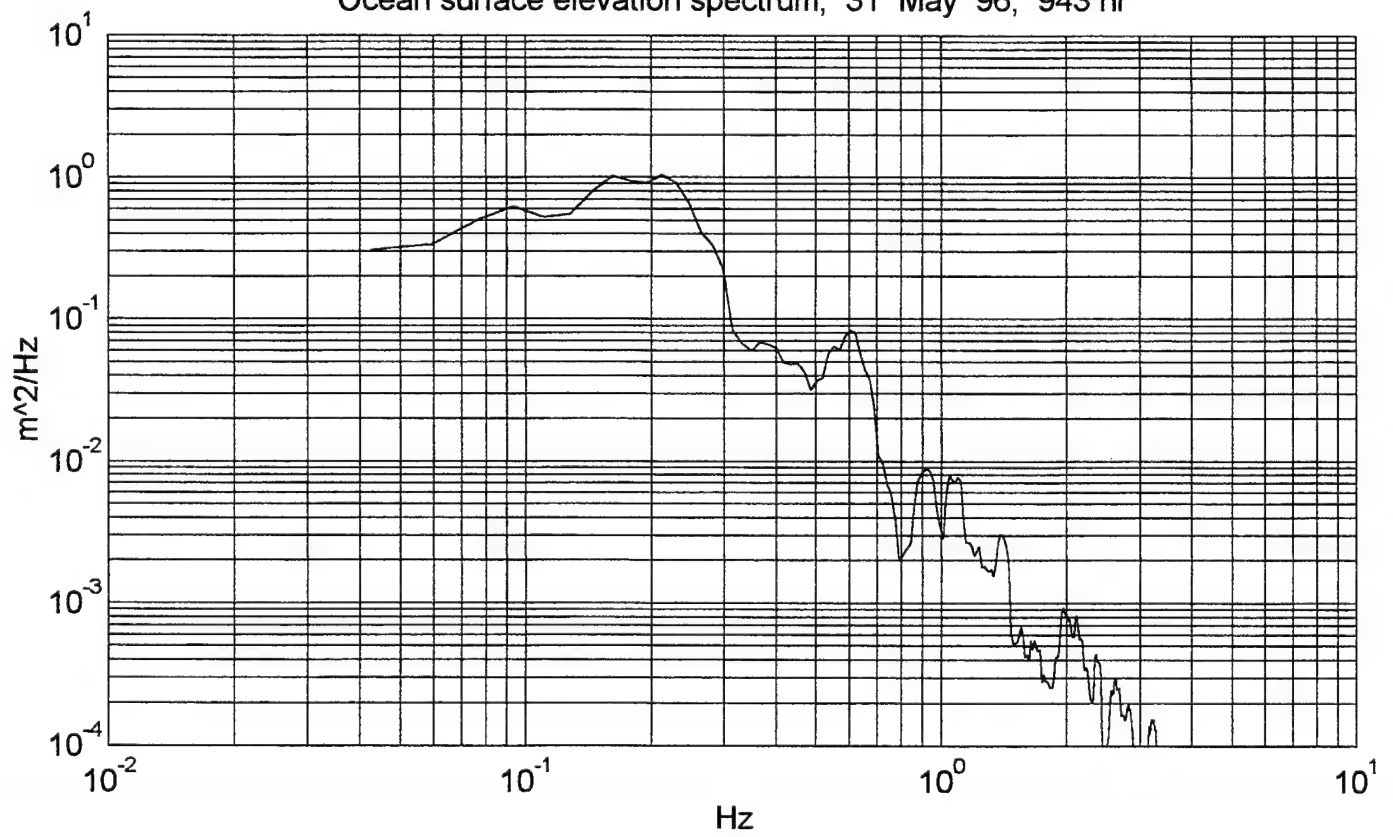
Ocean surface elevation spectrum, 30 May 96, 1909 hr



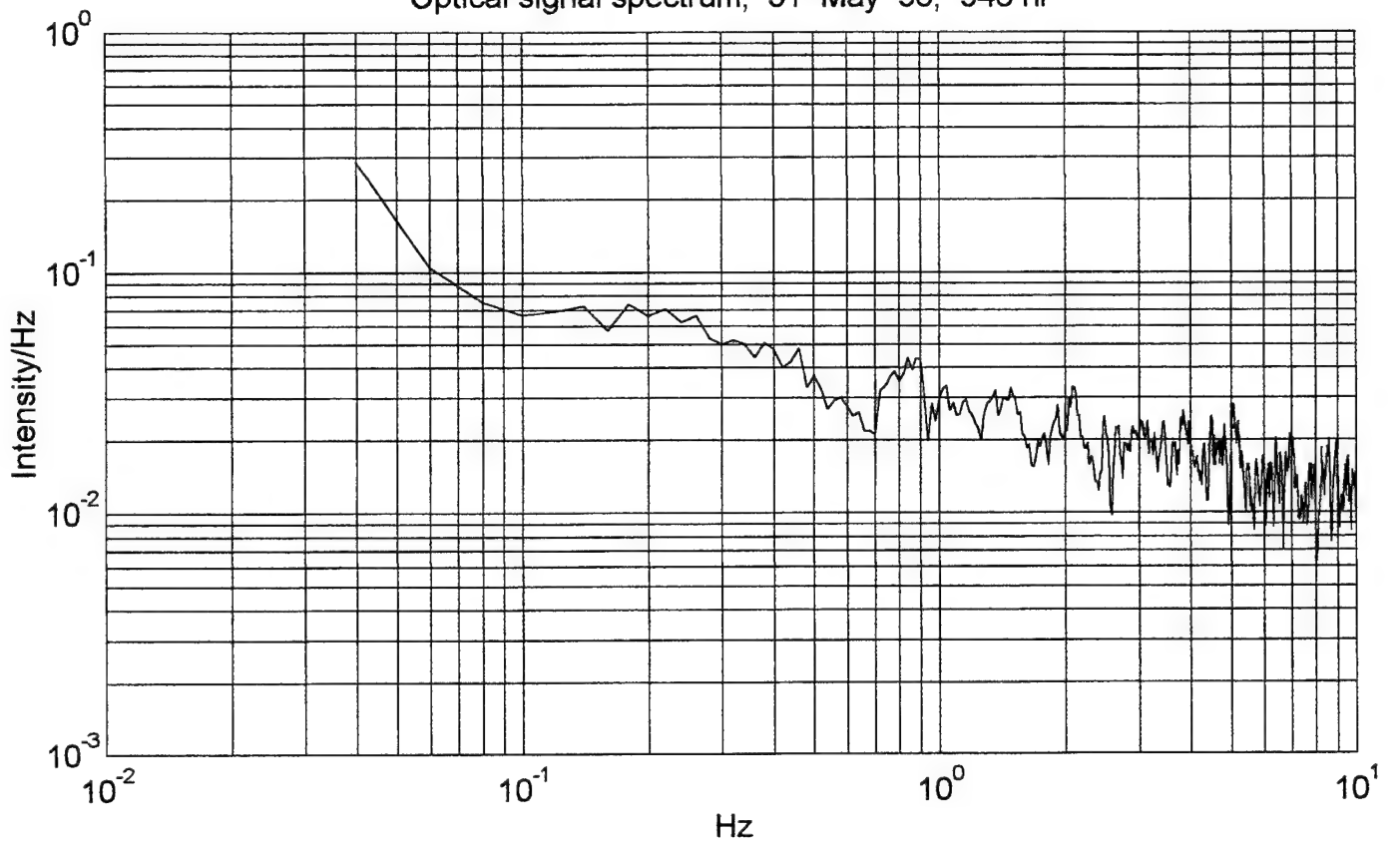
Optical signal spectrum, 31 May 96, 943 hr



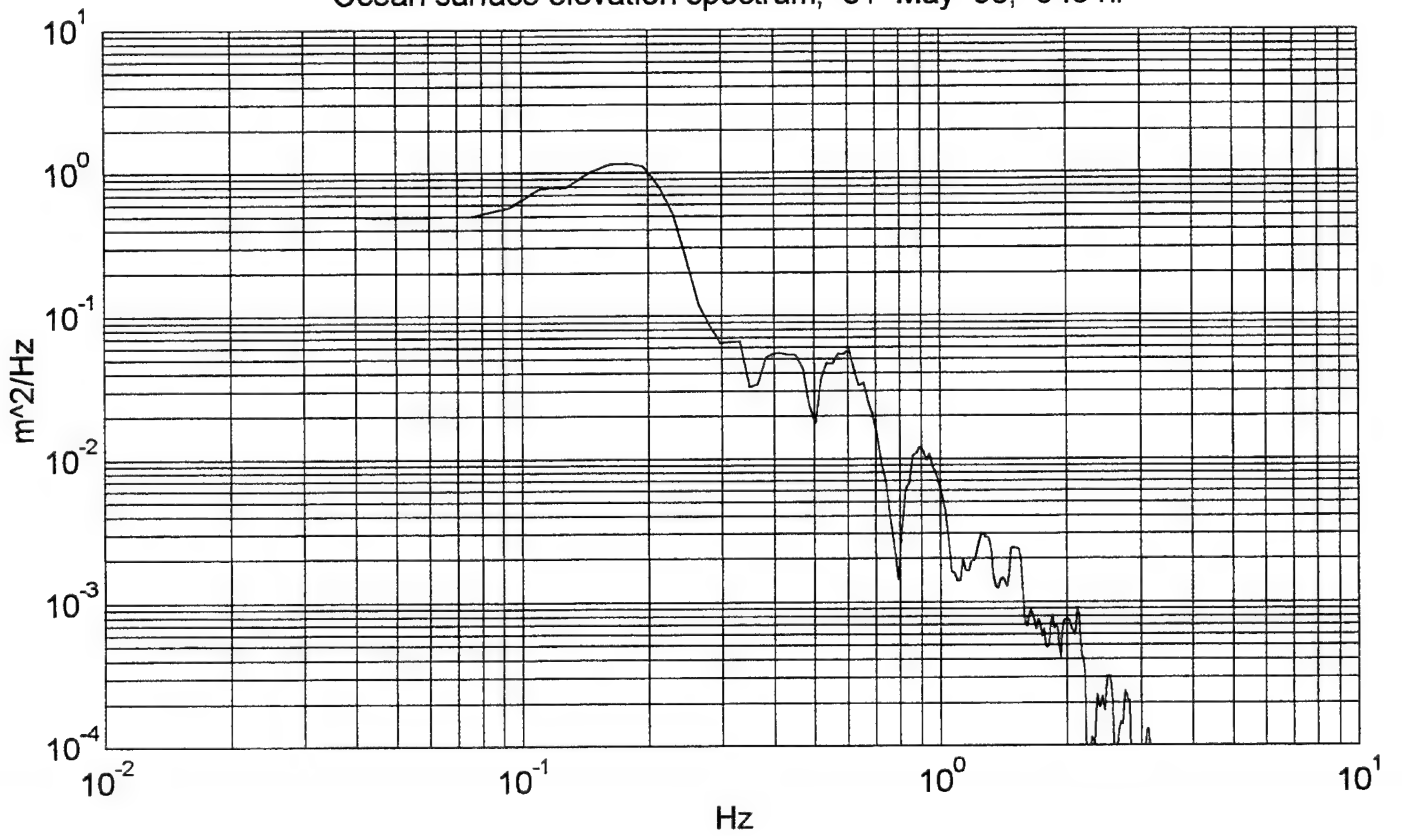
Ocean surface elevation spectrum, 31 May 96, 943 hr



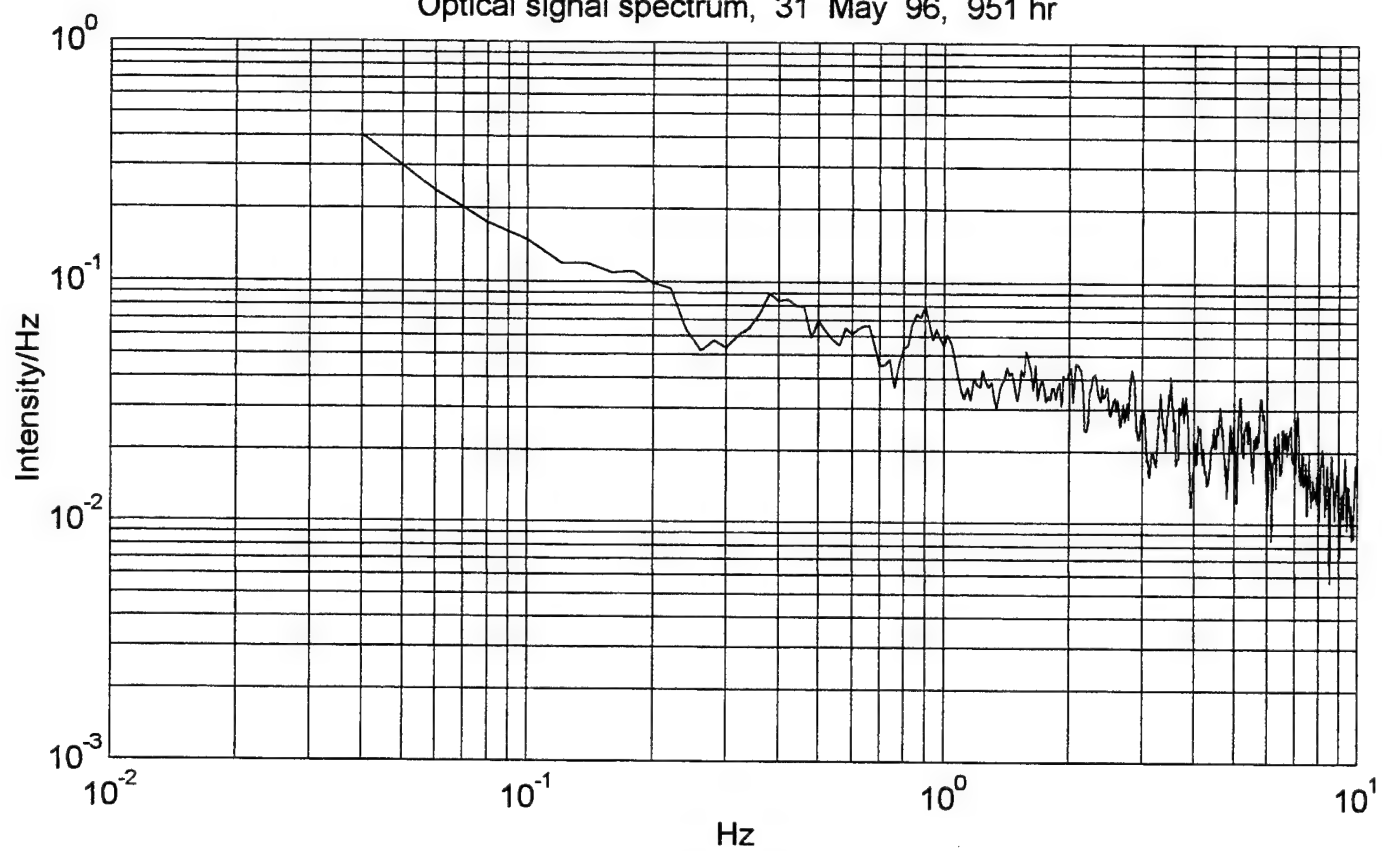
Optical signal spectrum, 31 May 96, 946 hr



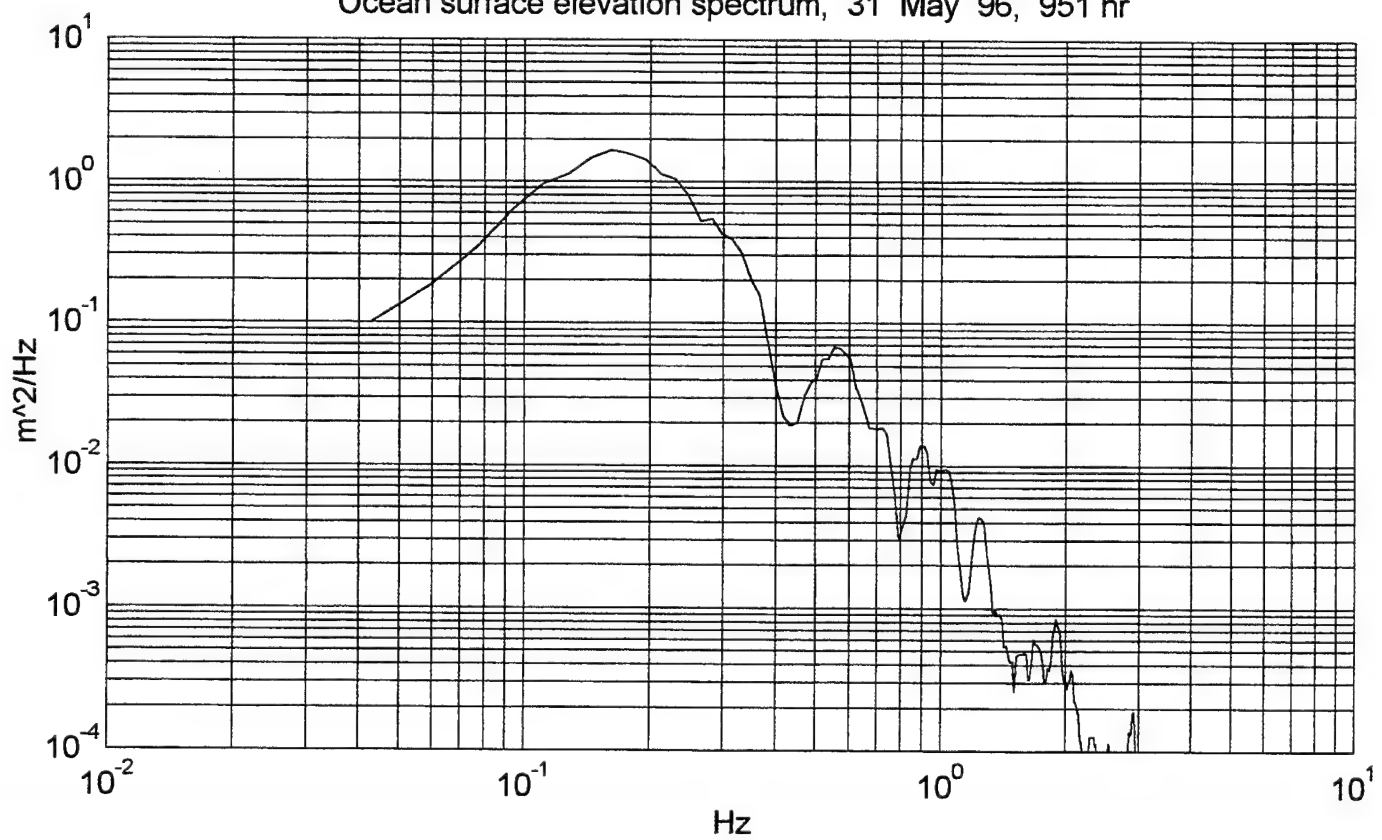
Ocean surface elevation spectrum, 31 May 96, 946 hr



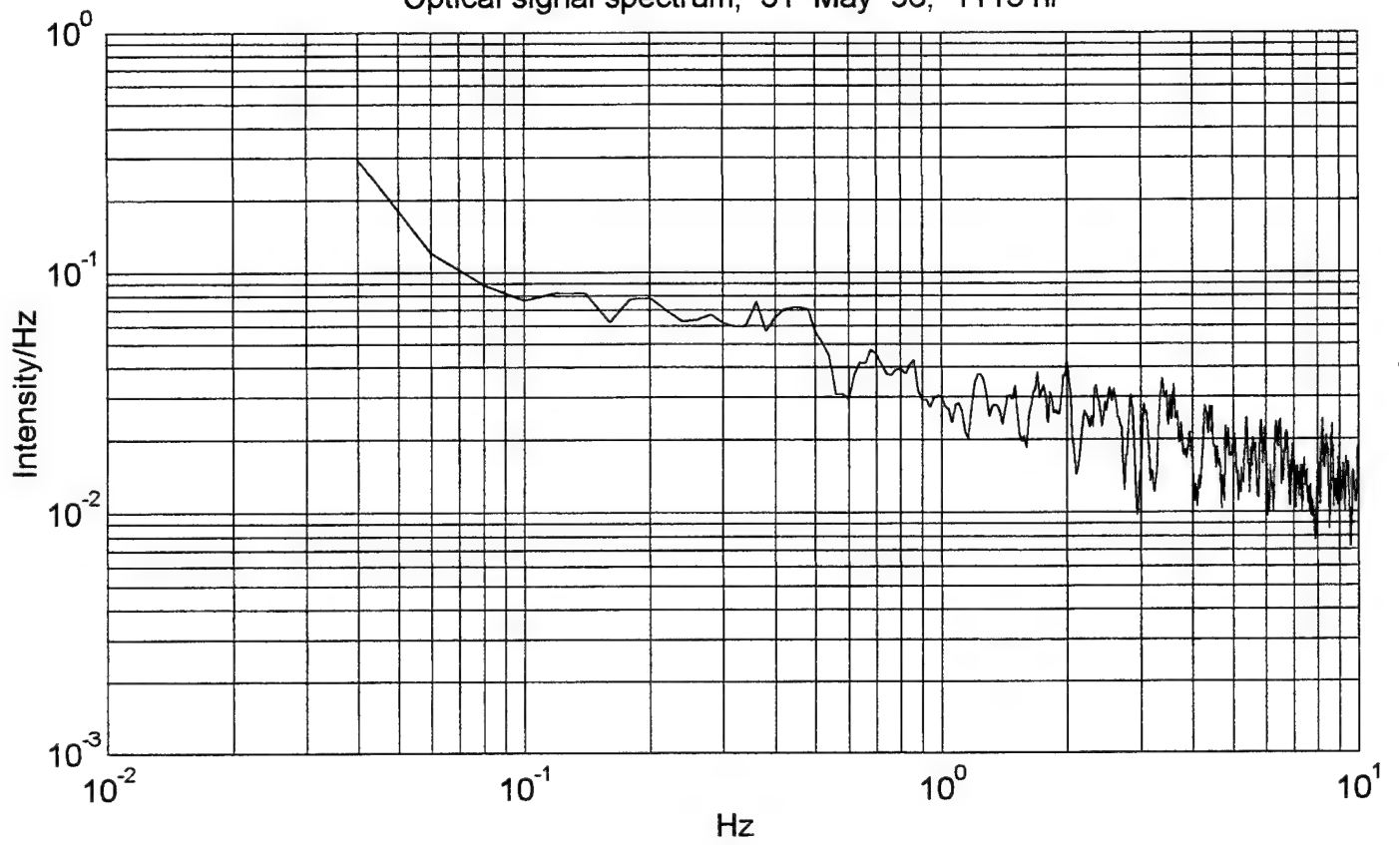
Optical signal spectrum, 31 May 96, 951 hr



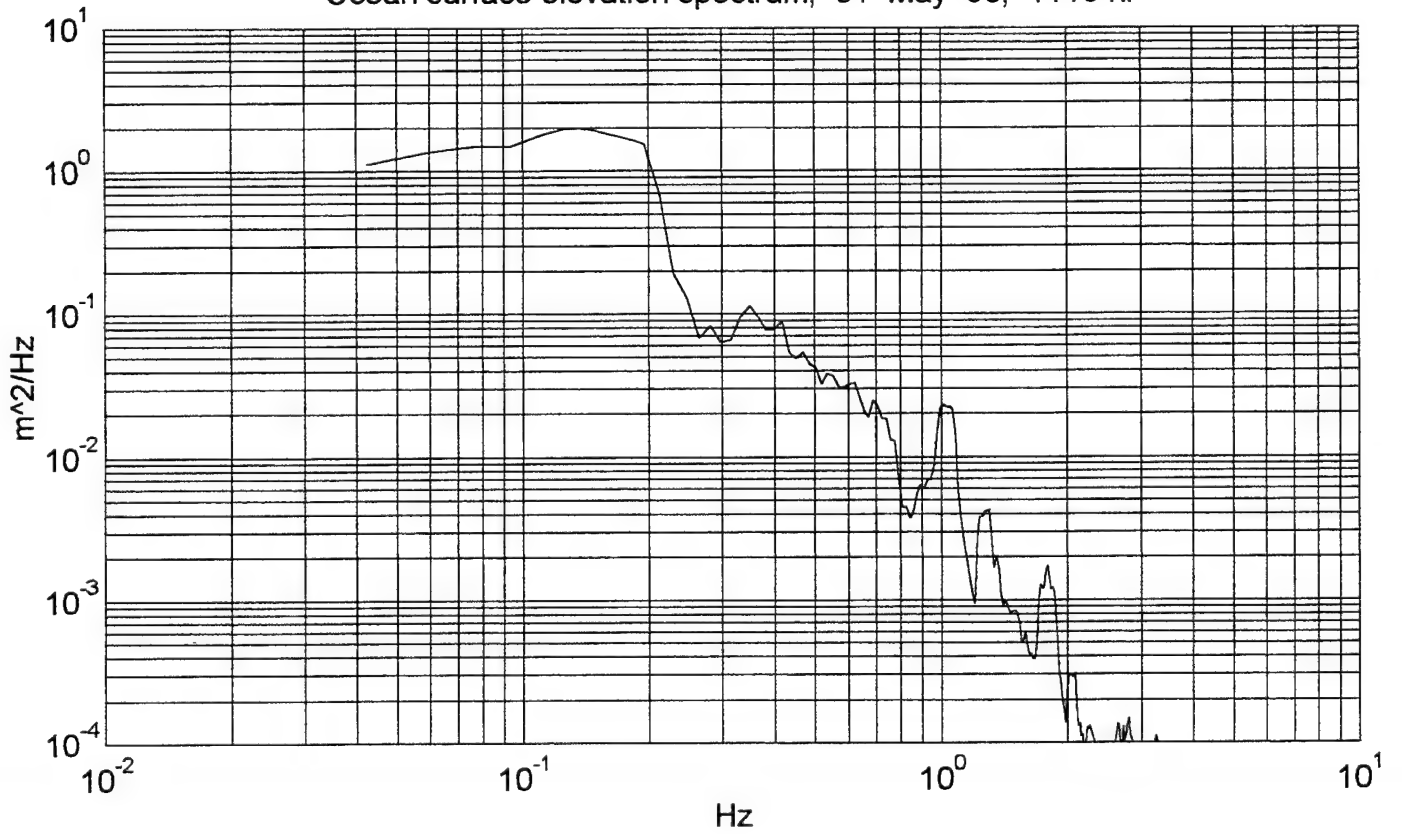
Ocean surface elevation spectrum, 31 May 96, 951 hr



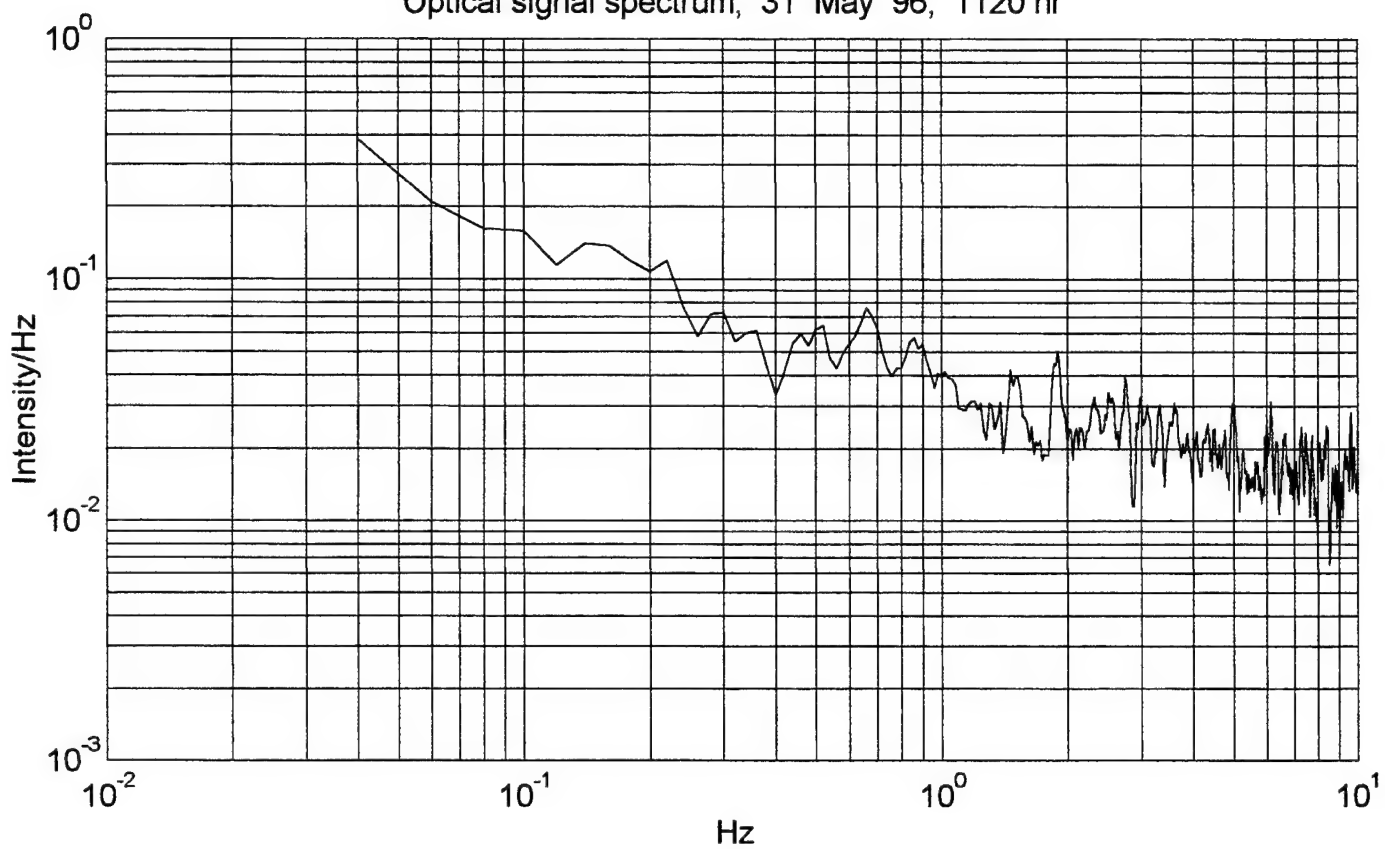
Optical signal spectrum, 31 May 96, 1115 hr



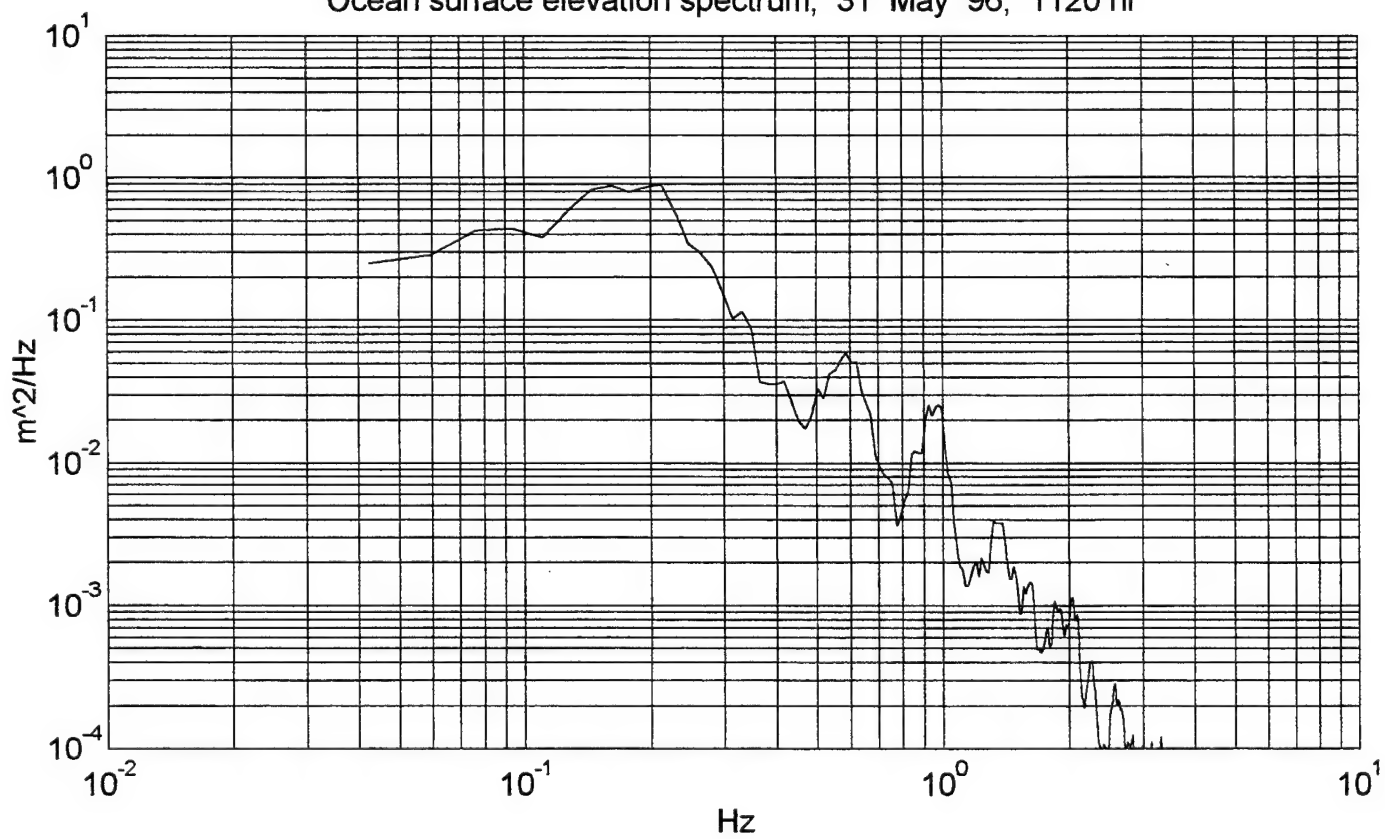
Ocean surface elevation spectrum, 31 May 96, 1115 hr



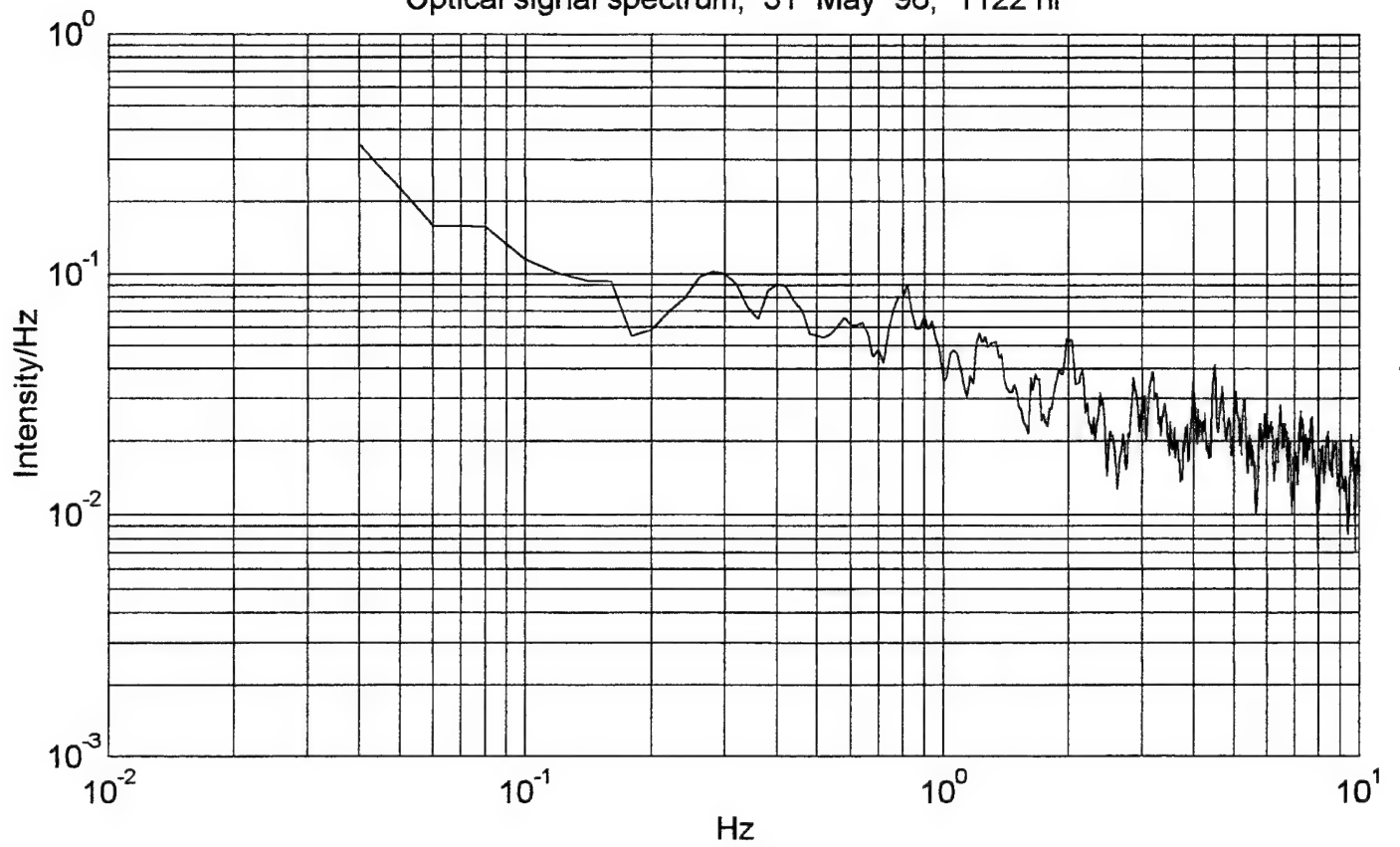
Optical signal spectrum, 31 May 96, 1120 hr



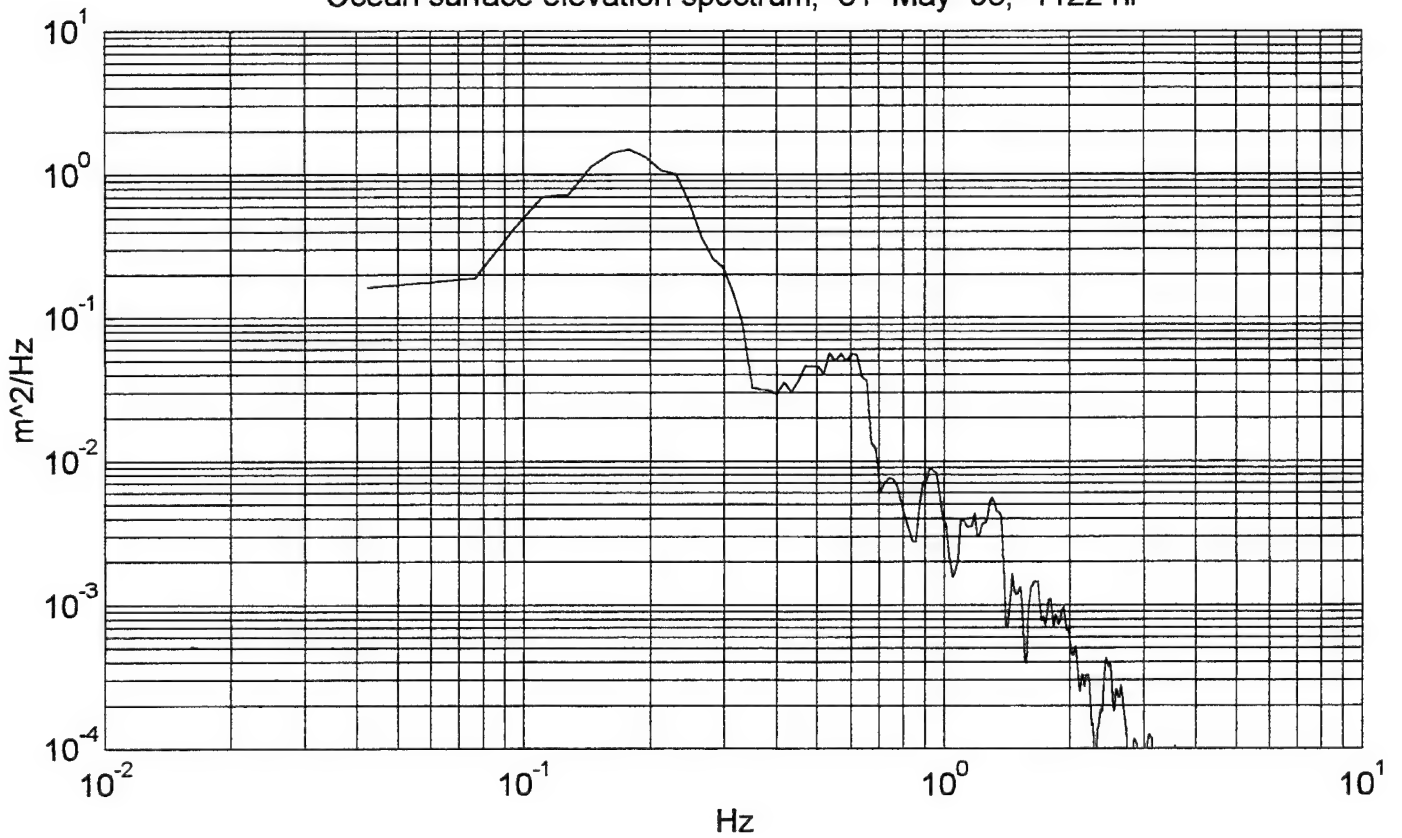
Ocean surface elevation spectrum, 31 May 96, 1120 hr



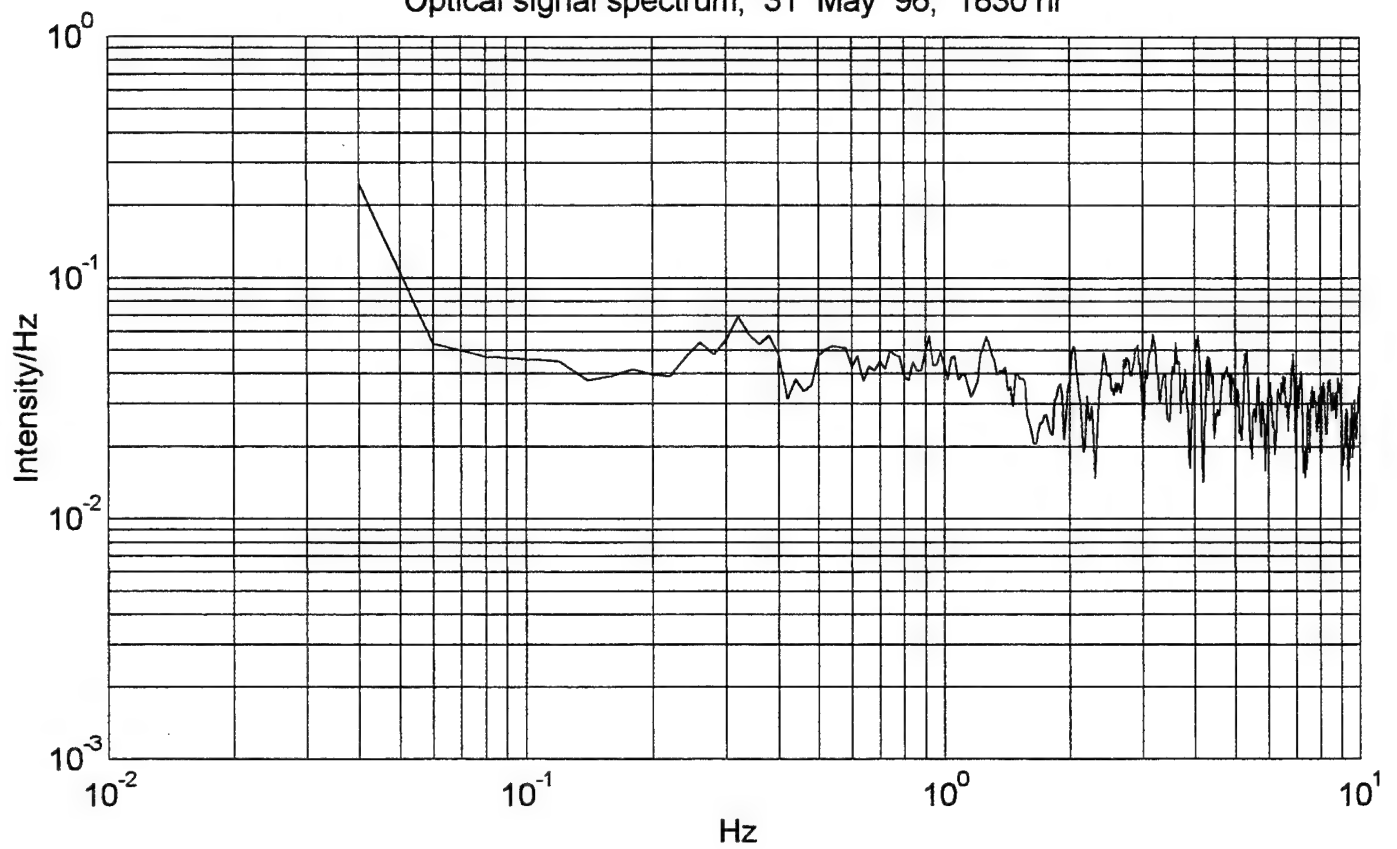
Optical signal spectrum, 31 May 96, 1122 hr



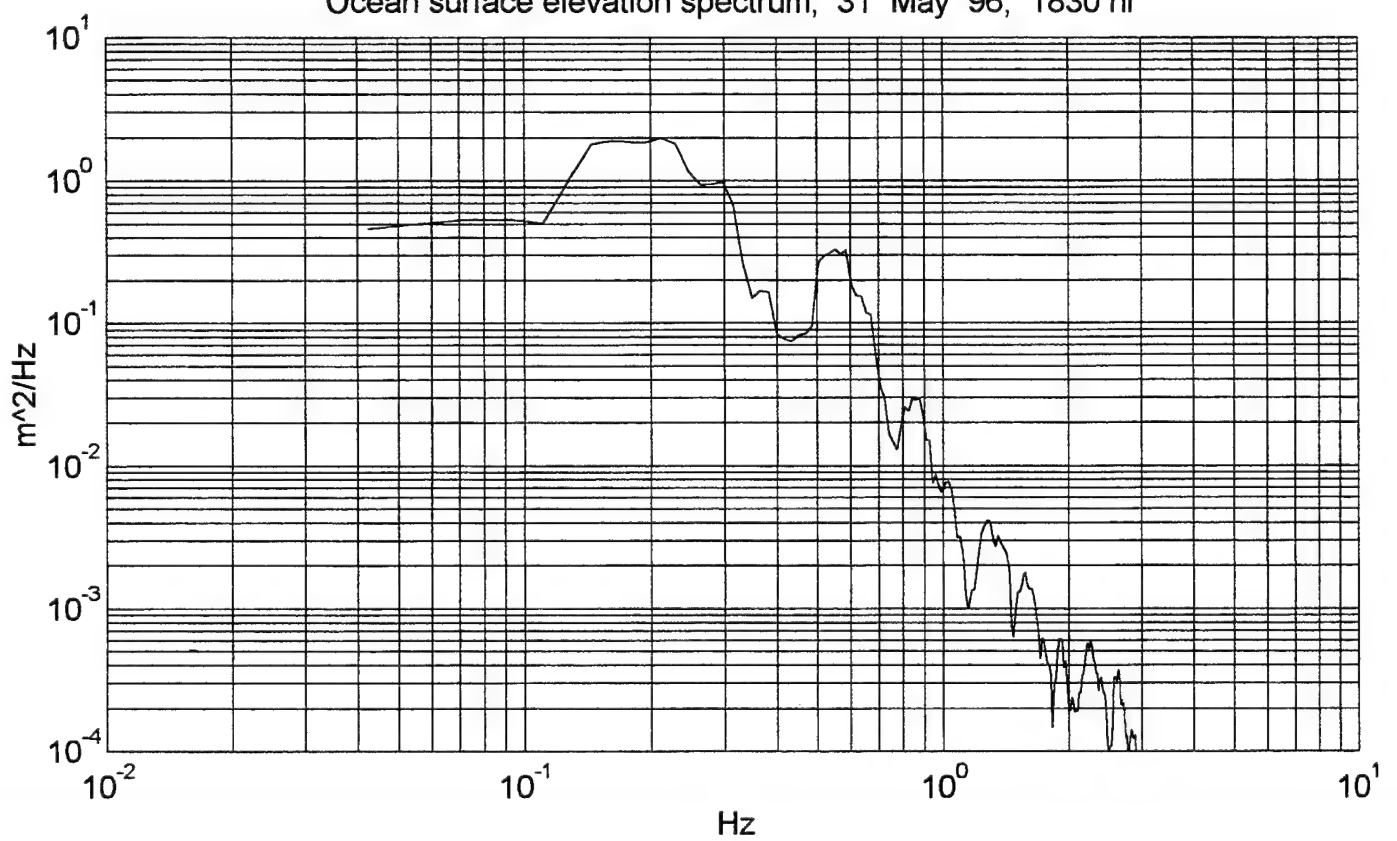
Ocean surface elevation spectrum, 31 May 96, 1122 hr



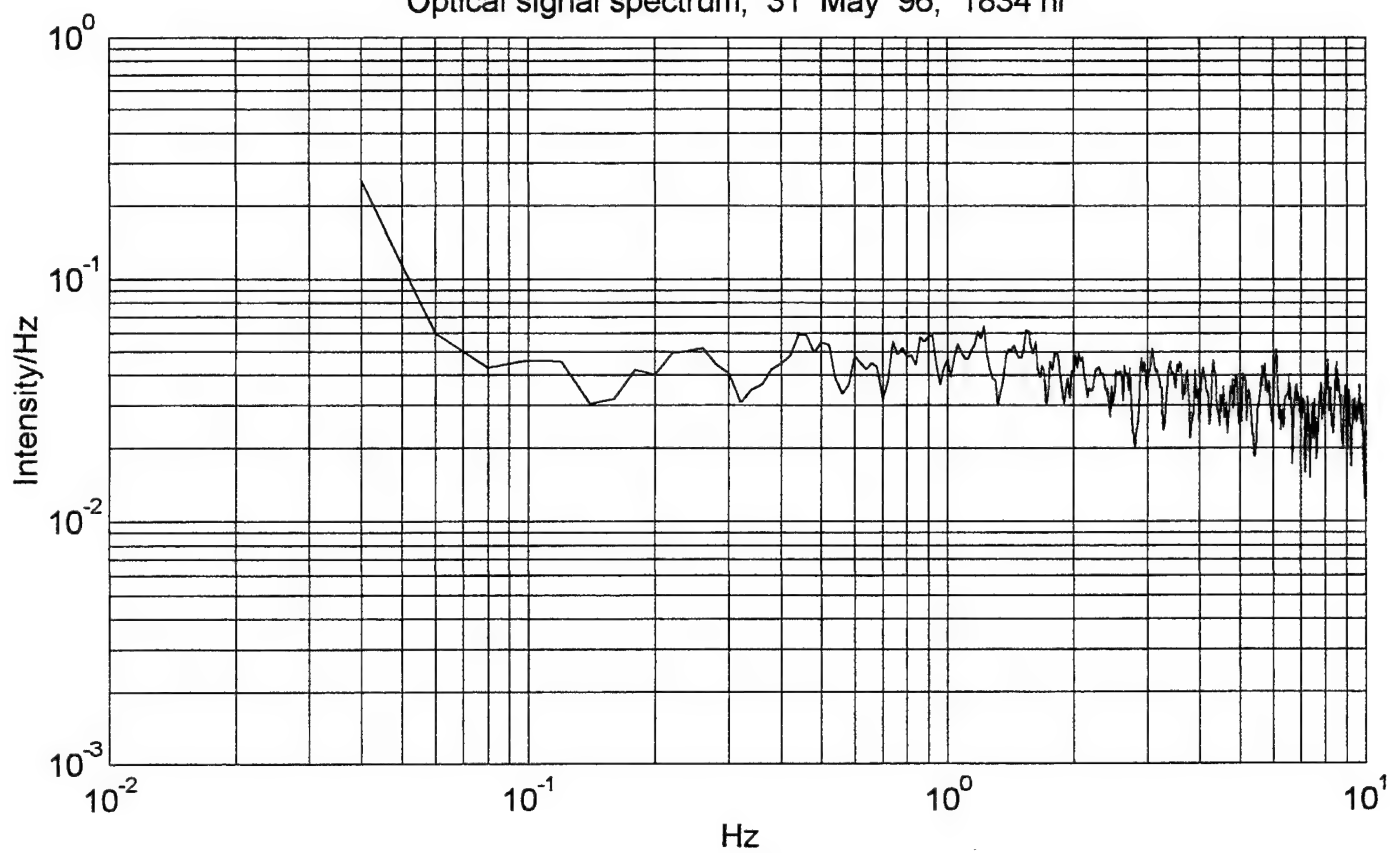
Optical signal spectrum, 31 May 96, 1830 hr



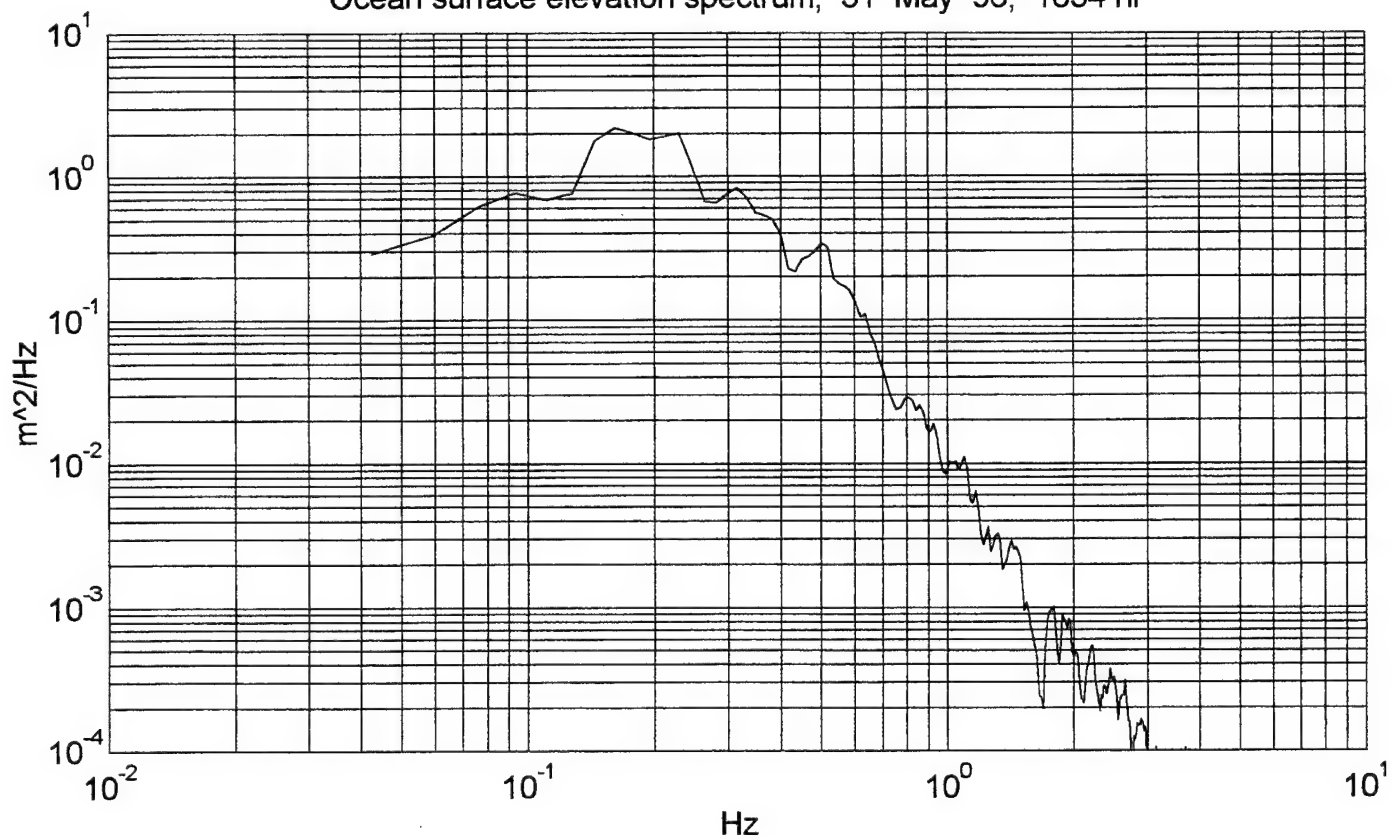
Ocean surface elevation spectrum, 31 May 96, 1830 hr



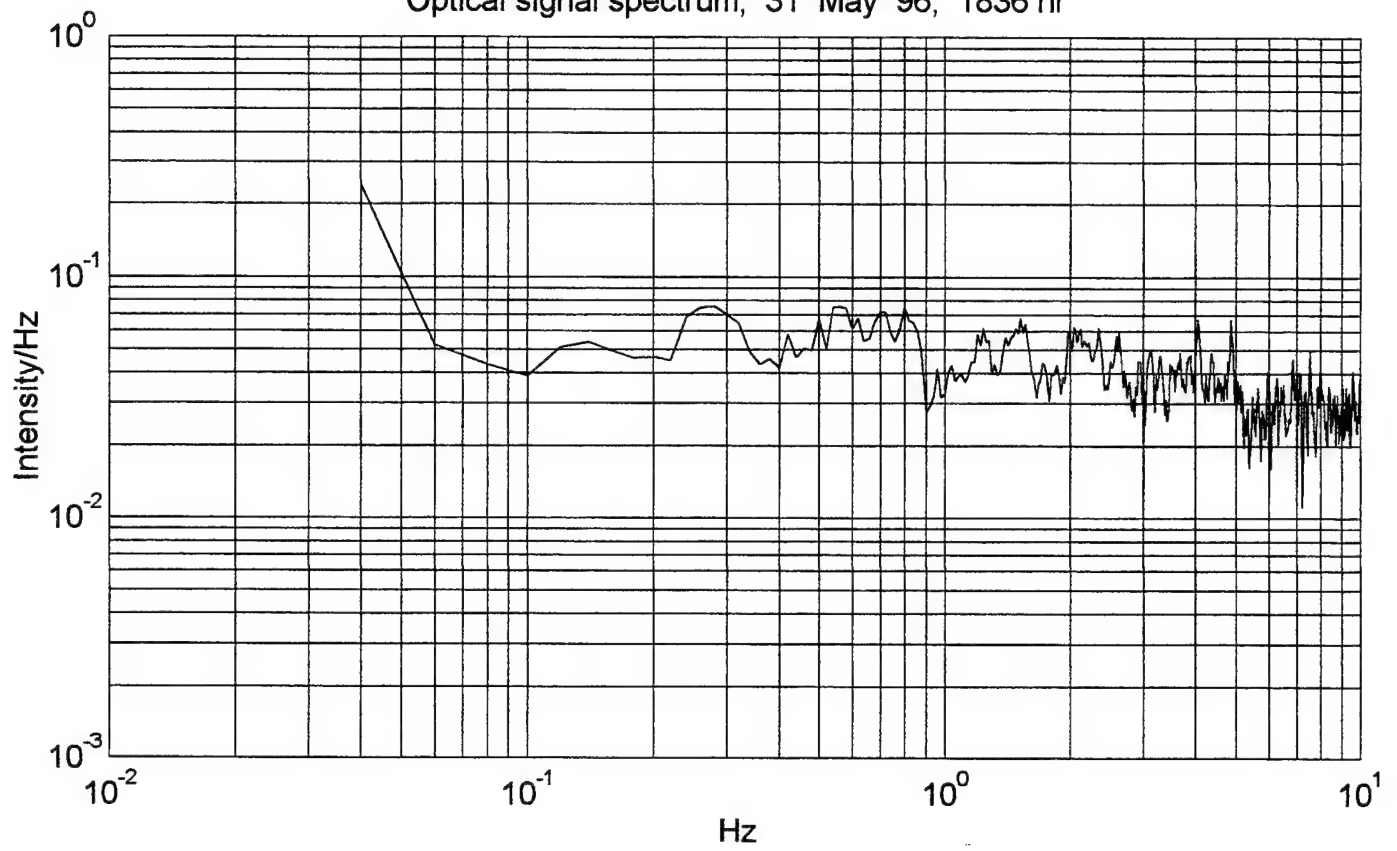
Optical signal spectrum, 31 May 96, 1834 hr



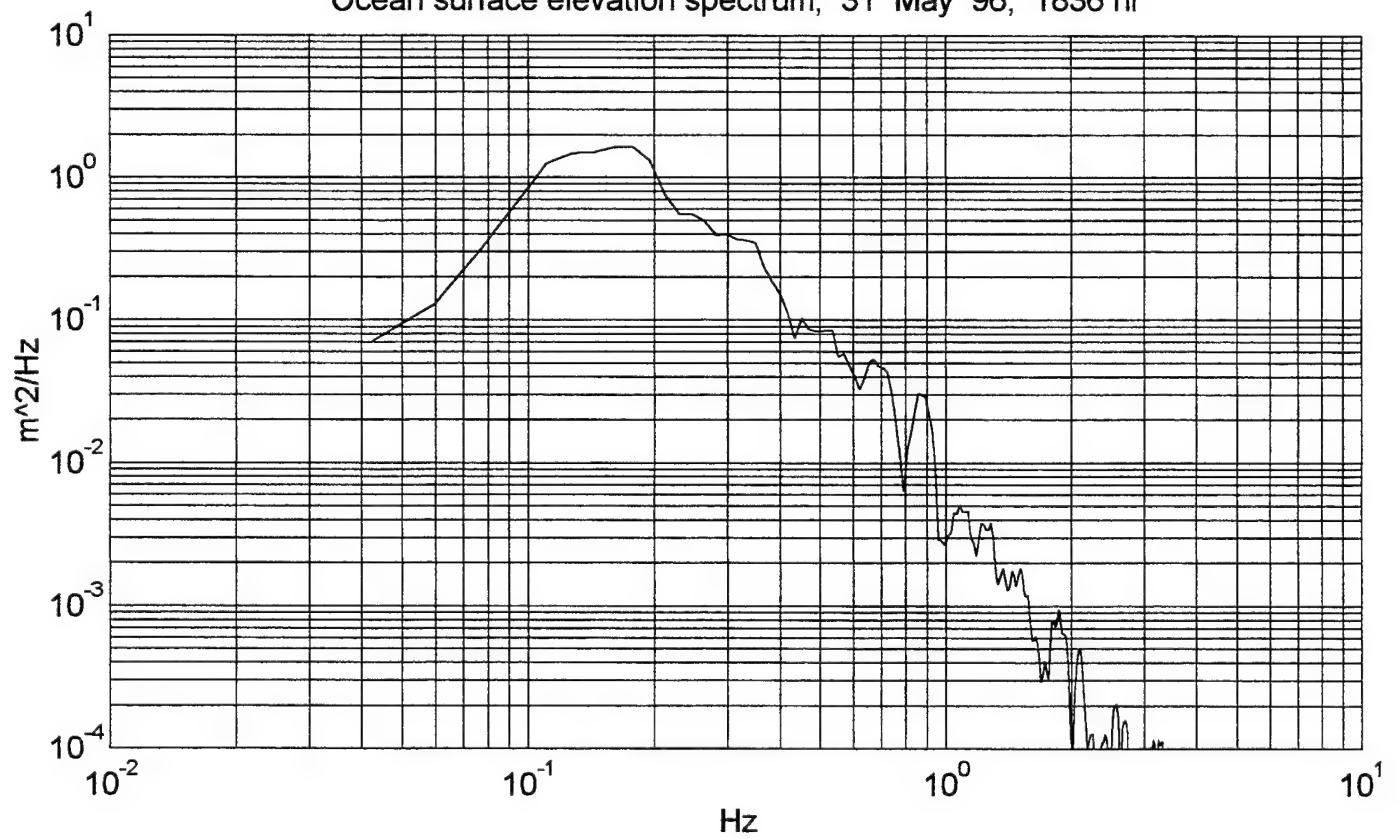
Ocean surface elevation spectrum, 31 May 96, 1834 hr



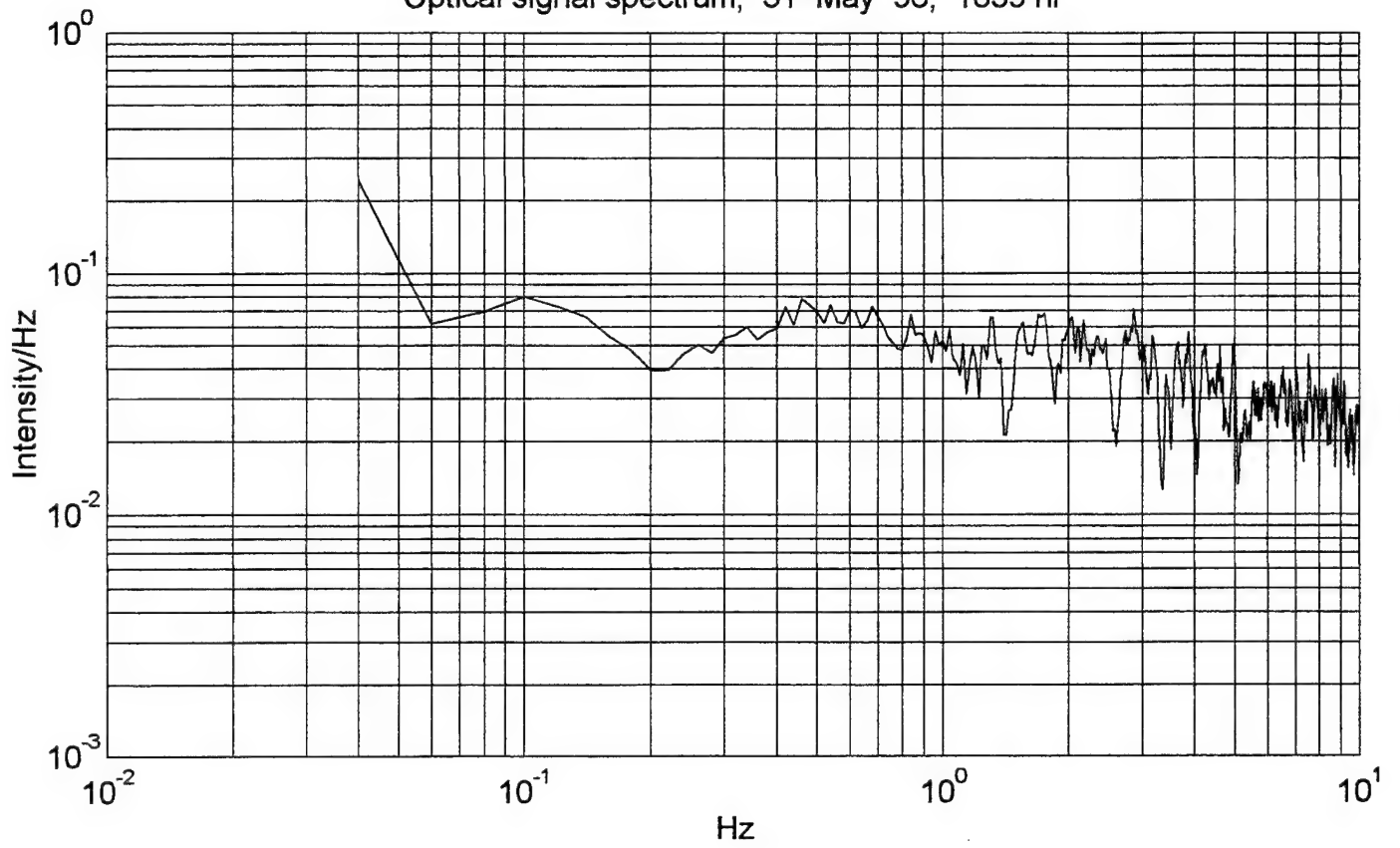
Optical signal spectrum, 31 May 96, 1836 hr



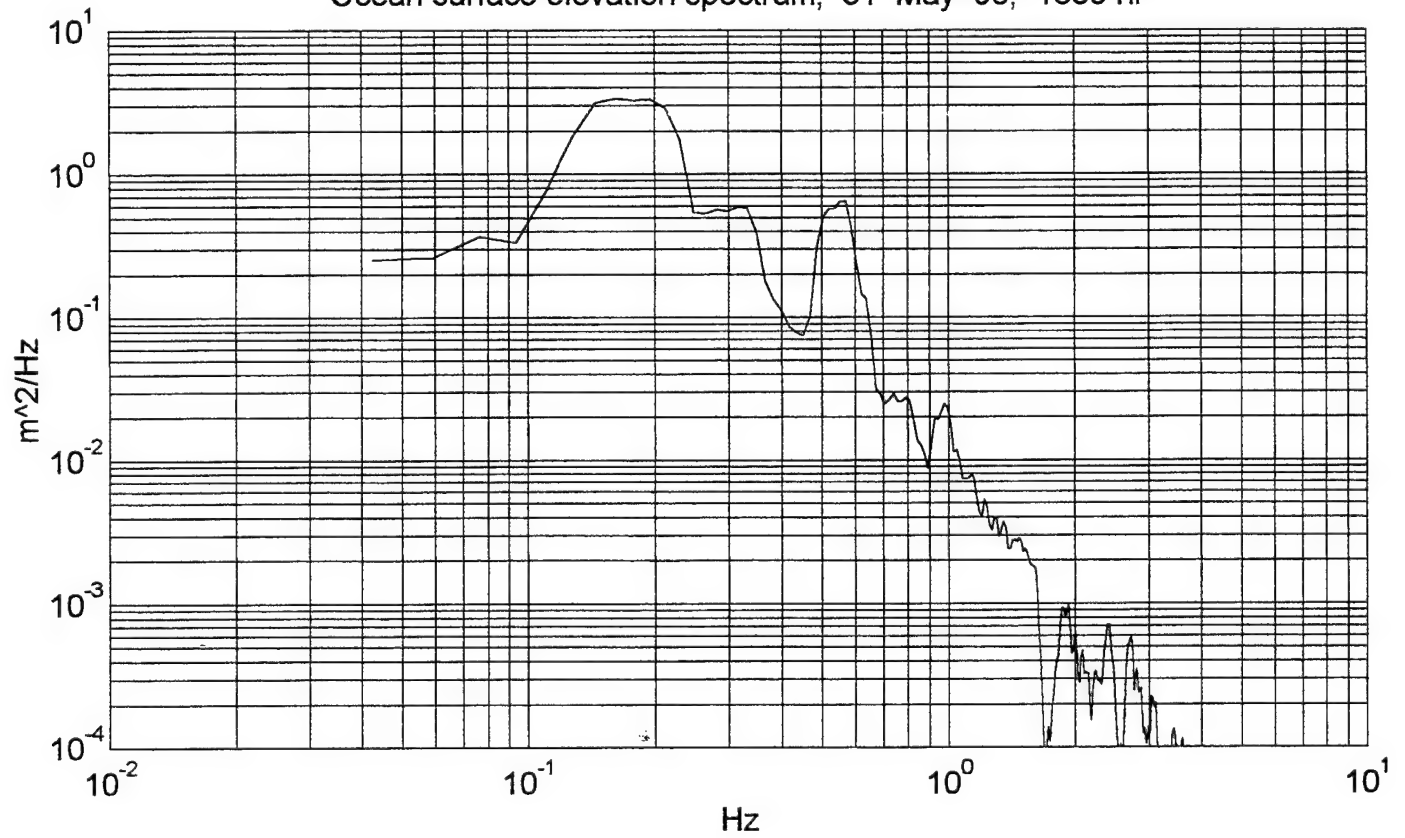
Ocean surface elevation spectrum, 31 May 96, 1836 hr



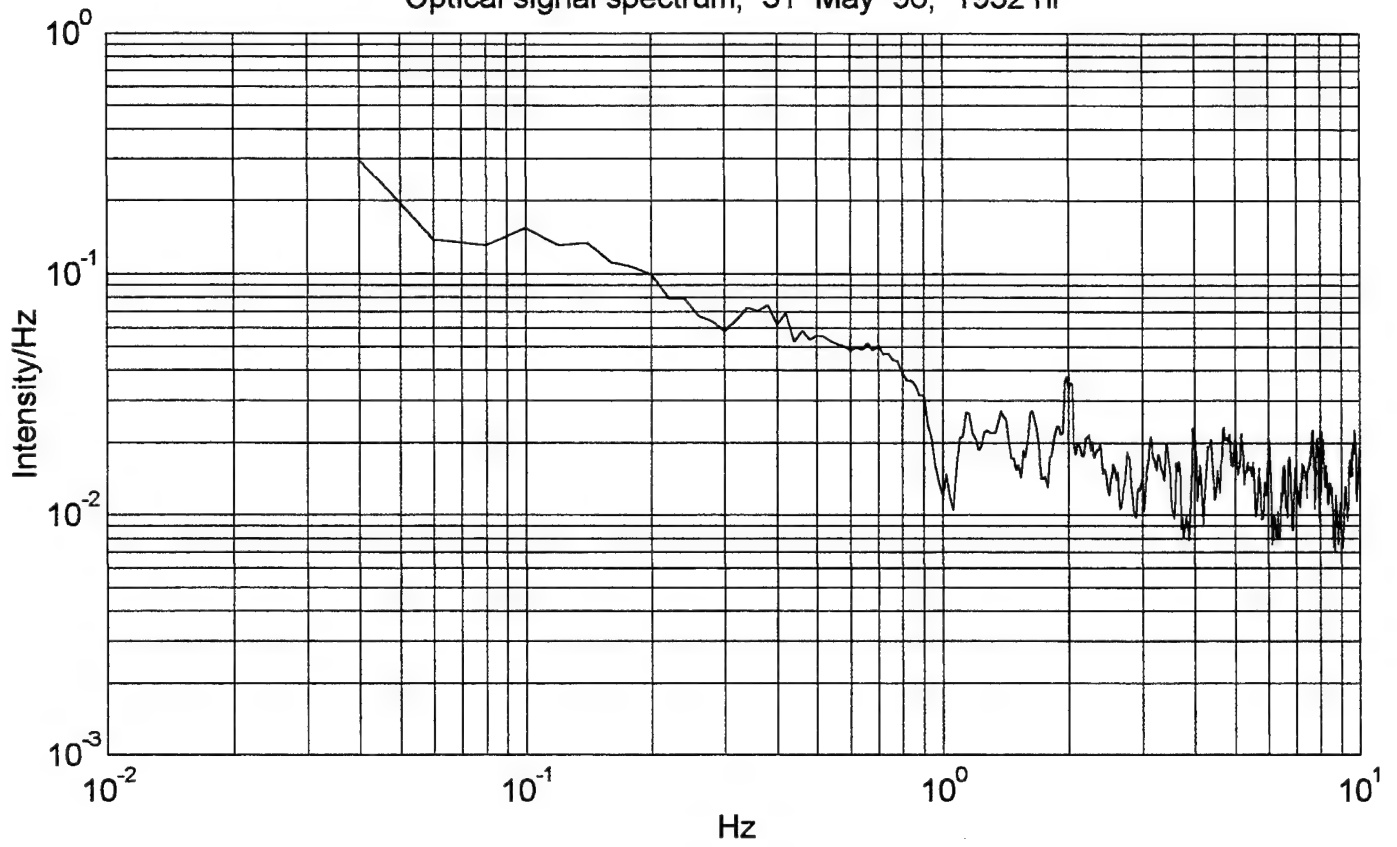
Optical signal spectrum, 31 May 96, 1839 hr



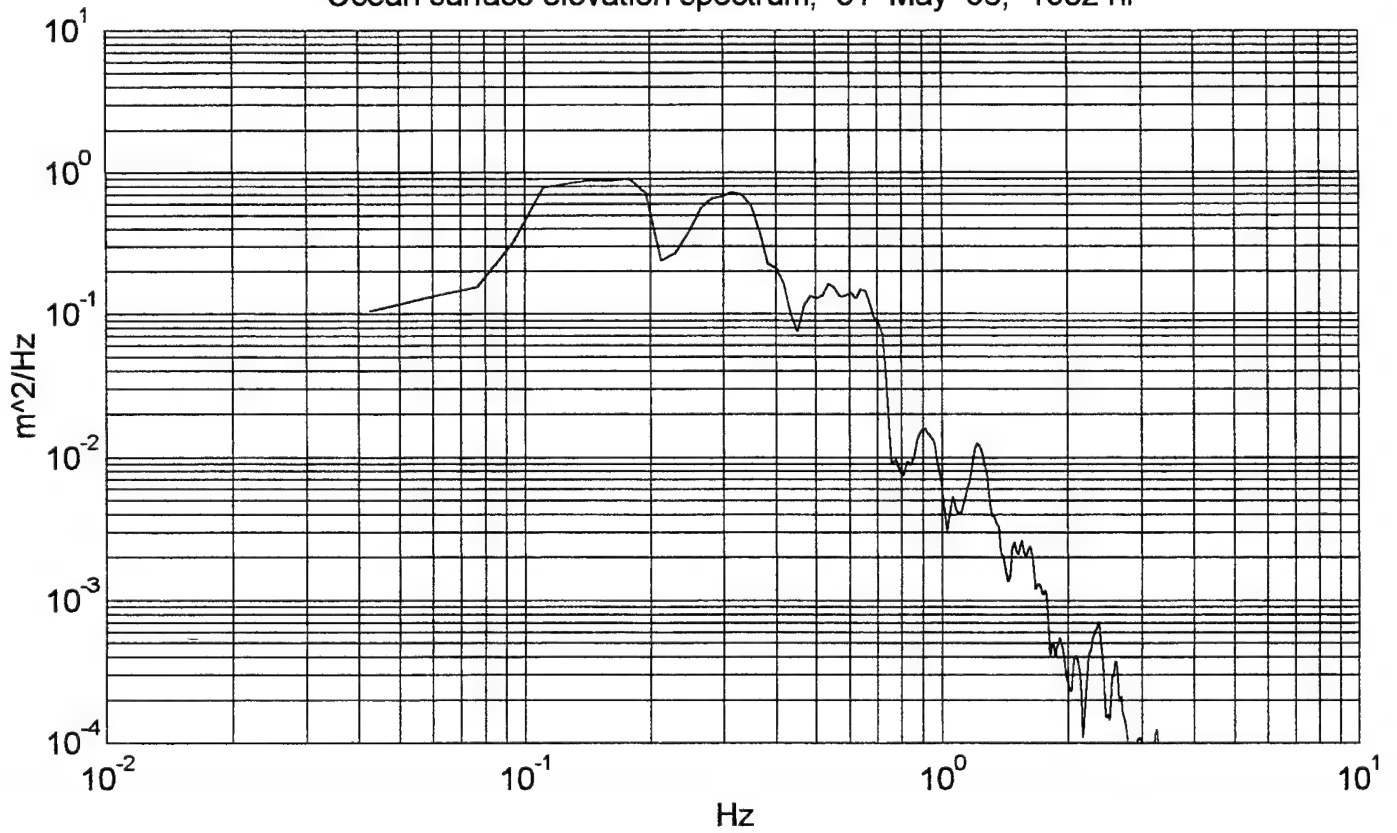
Ocean surface elevation spectrum, 31 May 96, 1839 hr



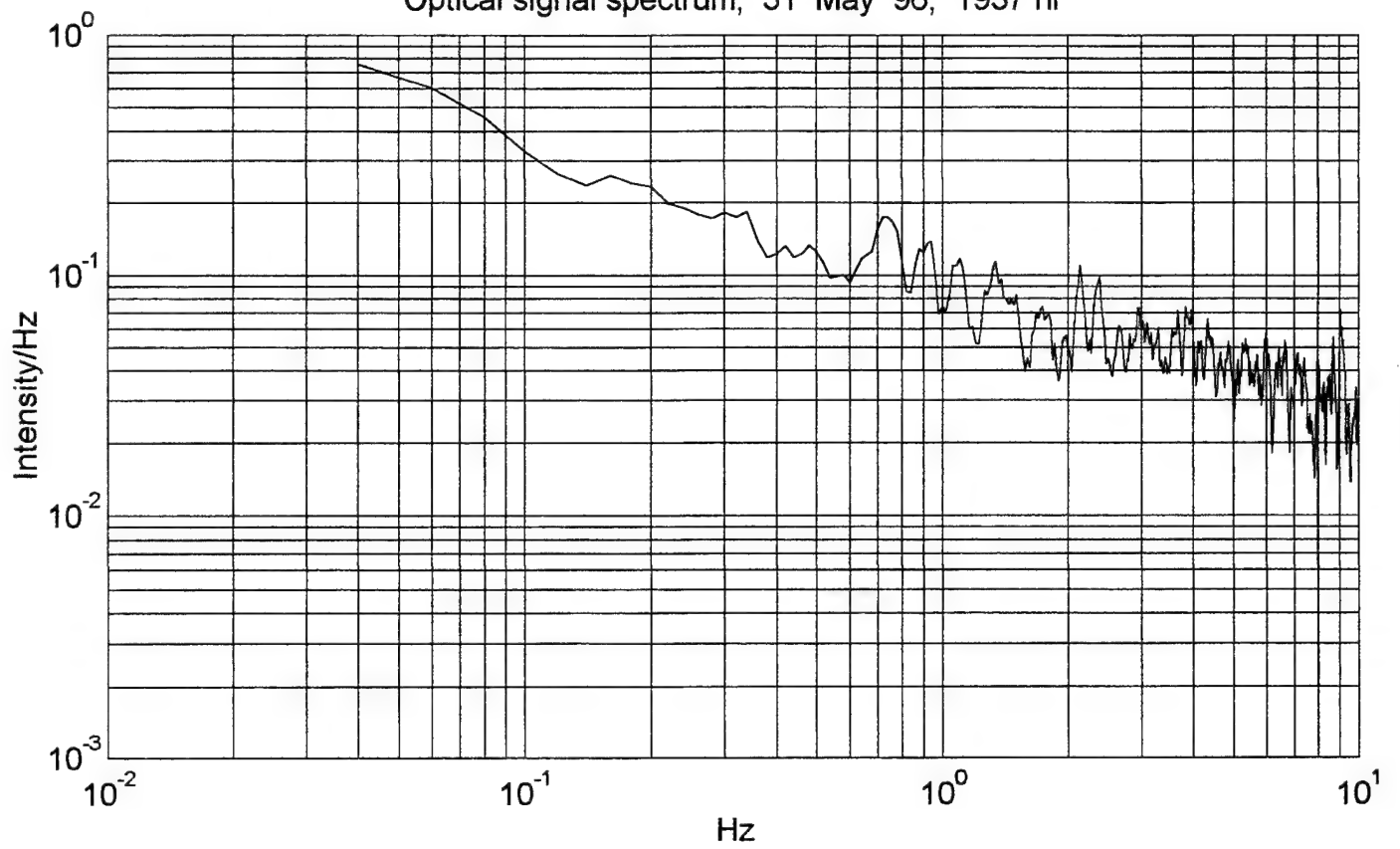
Optical signal spectrum, 31 May 96, 1932 hr



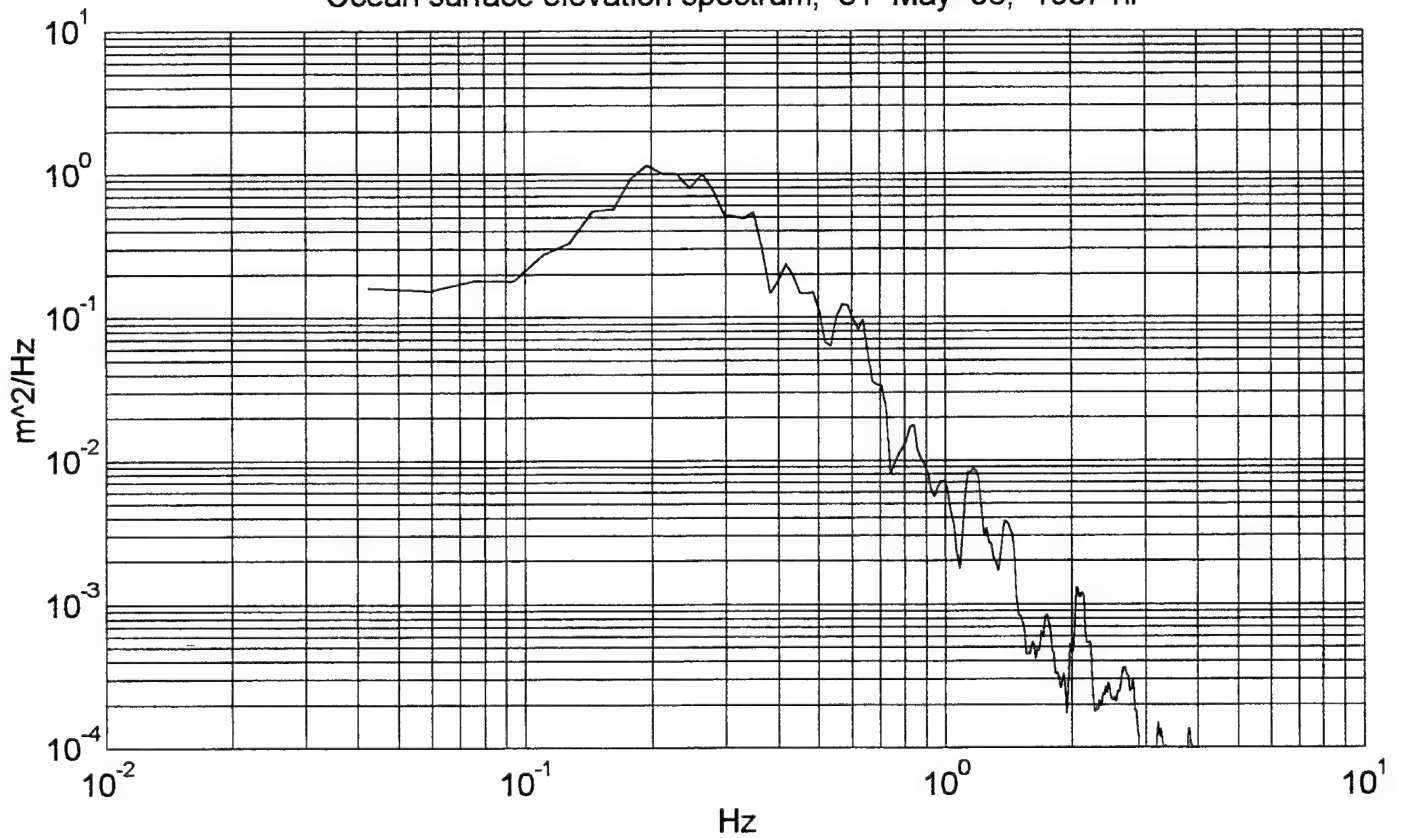
Ocean surface elevation spectrum, 31 May 96, 1932 hr



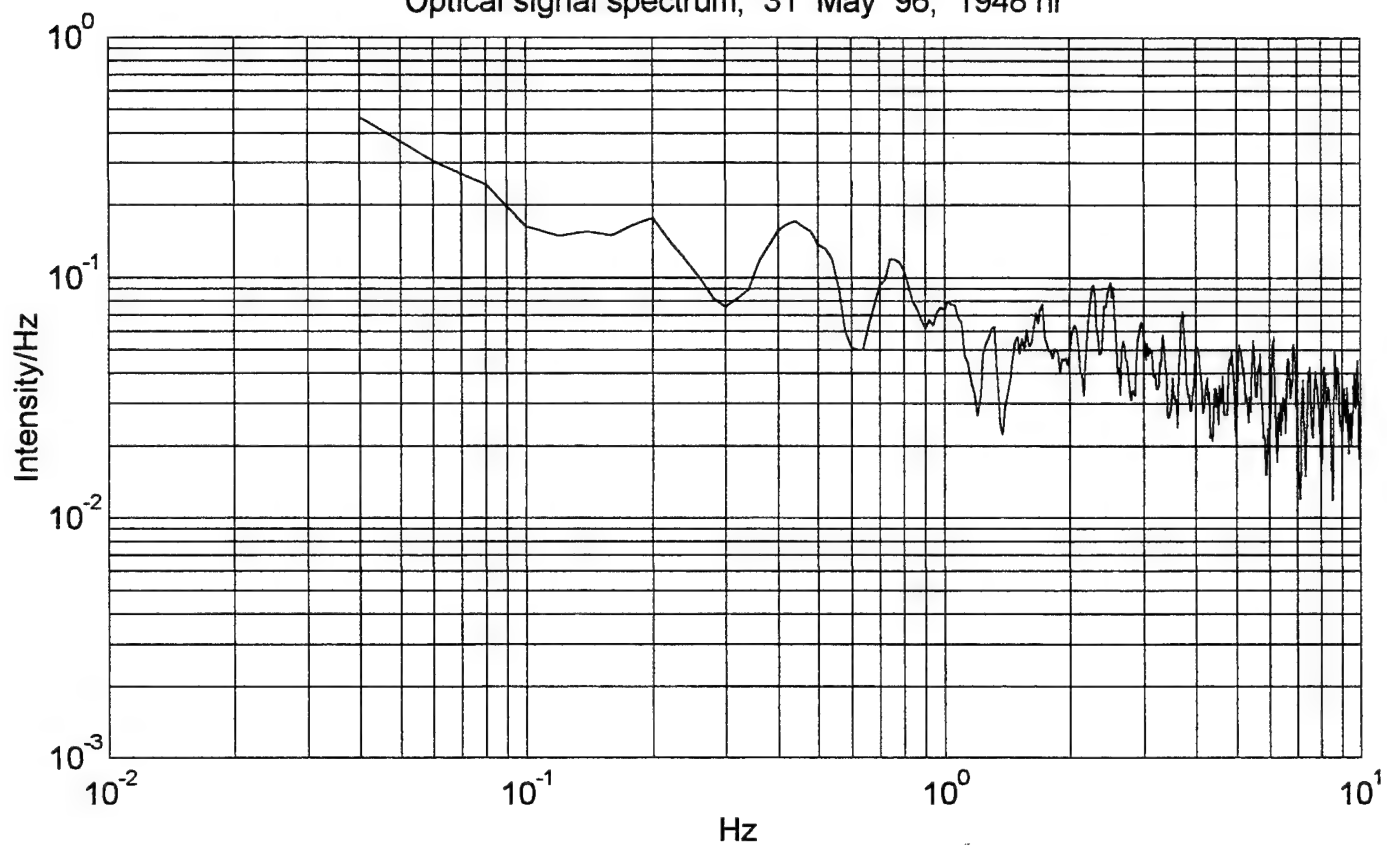
Optical signal spectrum, 31 May 96, 1937 hr



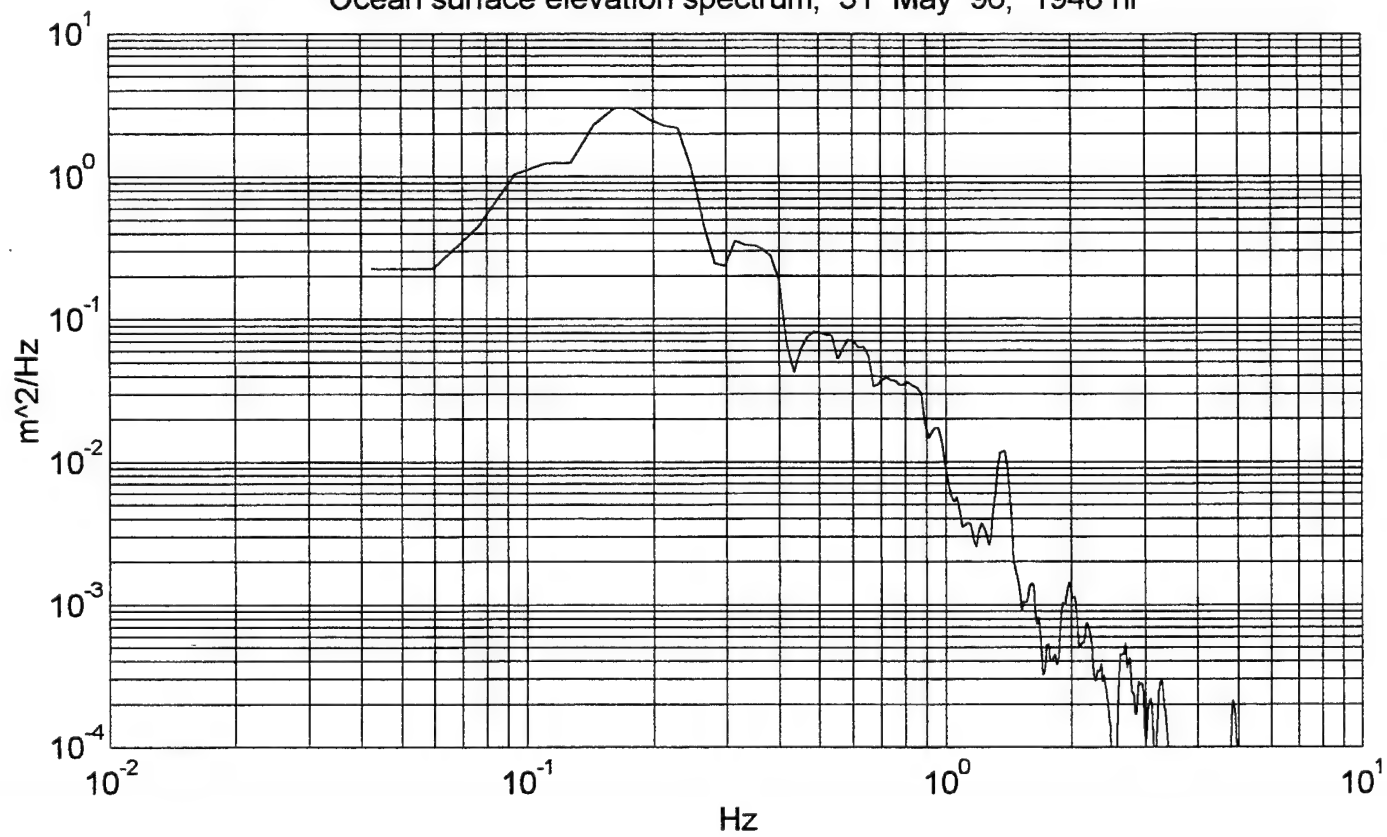
Ocean surface elevation spectrum, 31 May 96, 1937 hr



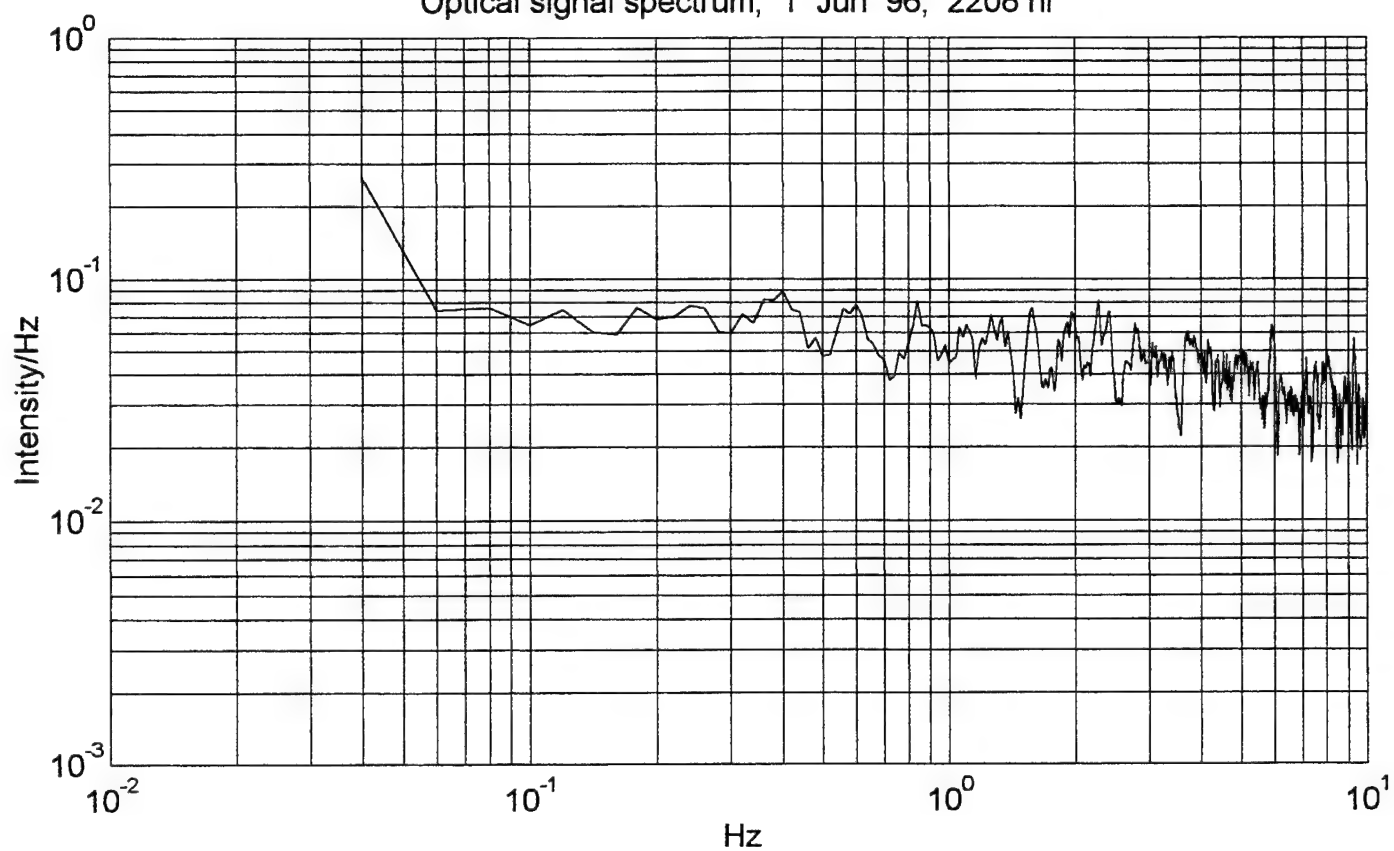
Optical signal spectrum, 31 May 96, 1948 hr



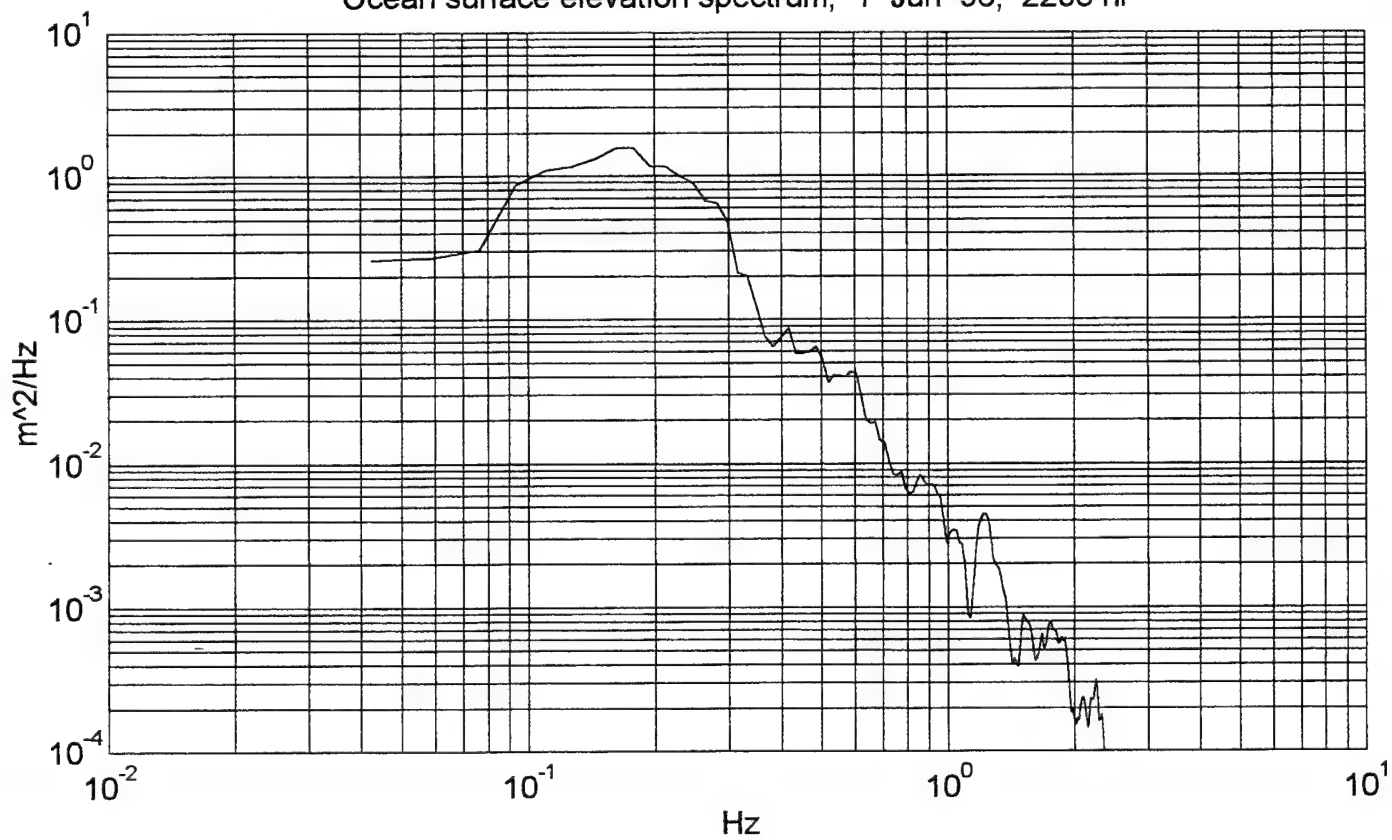
Ocean surface elevation spectrum, 31 May 96, 1948 hr



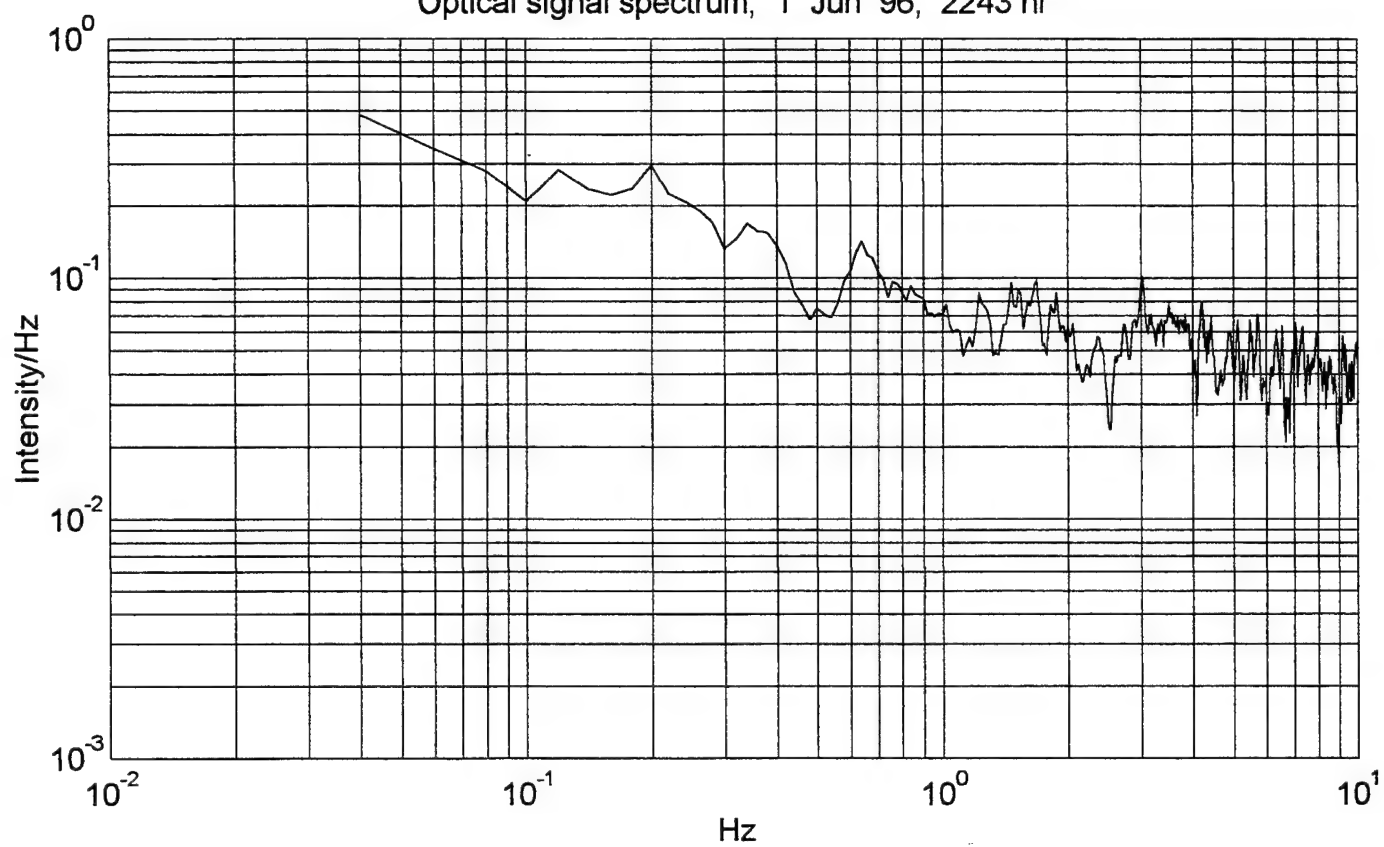
Optical signal spectrum, 1 Jun 96, 2208 hr



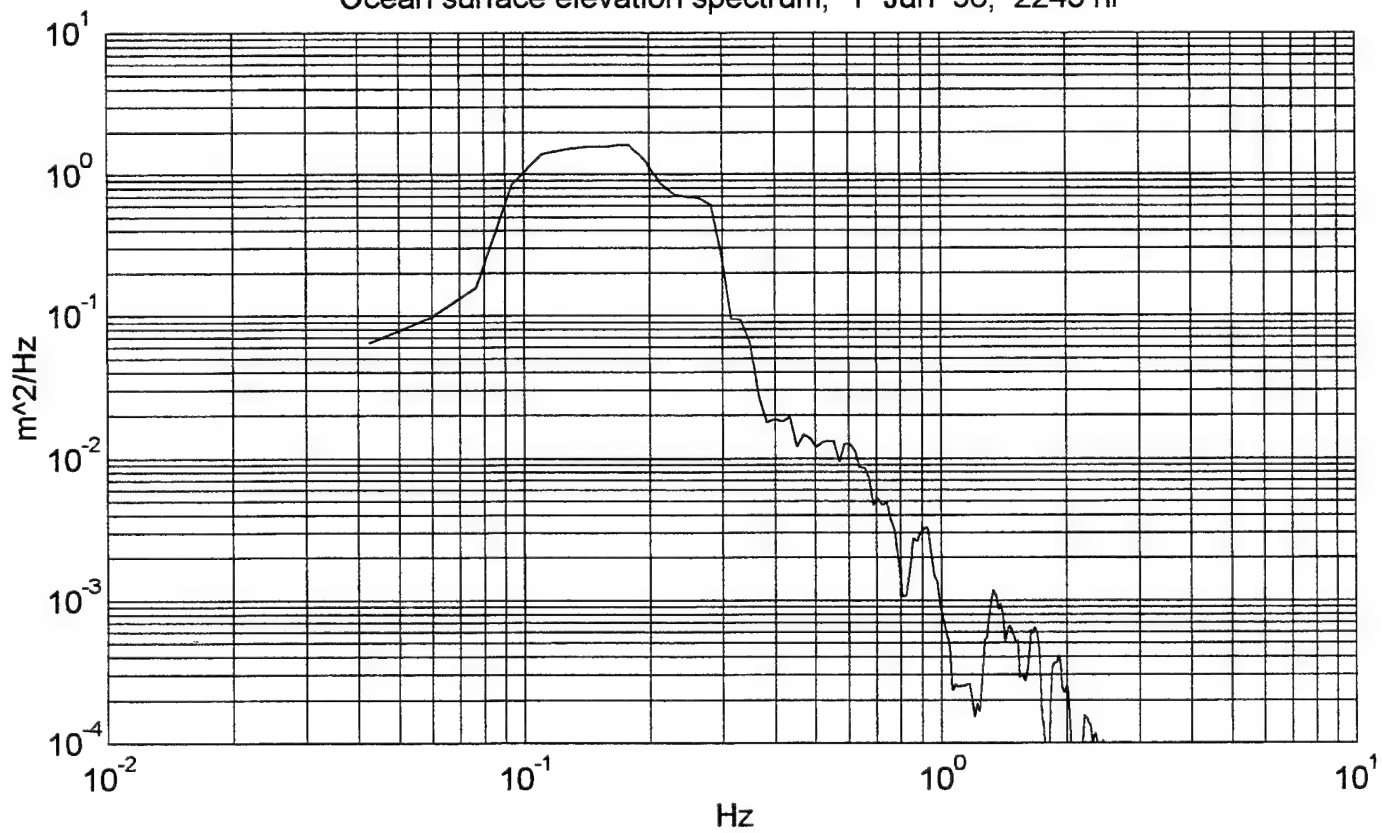
Ocean surface elevation spectrum, 1 Jun 96, 2208 hr



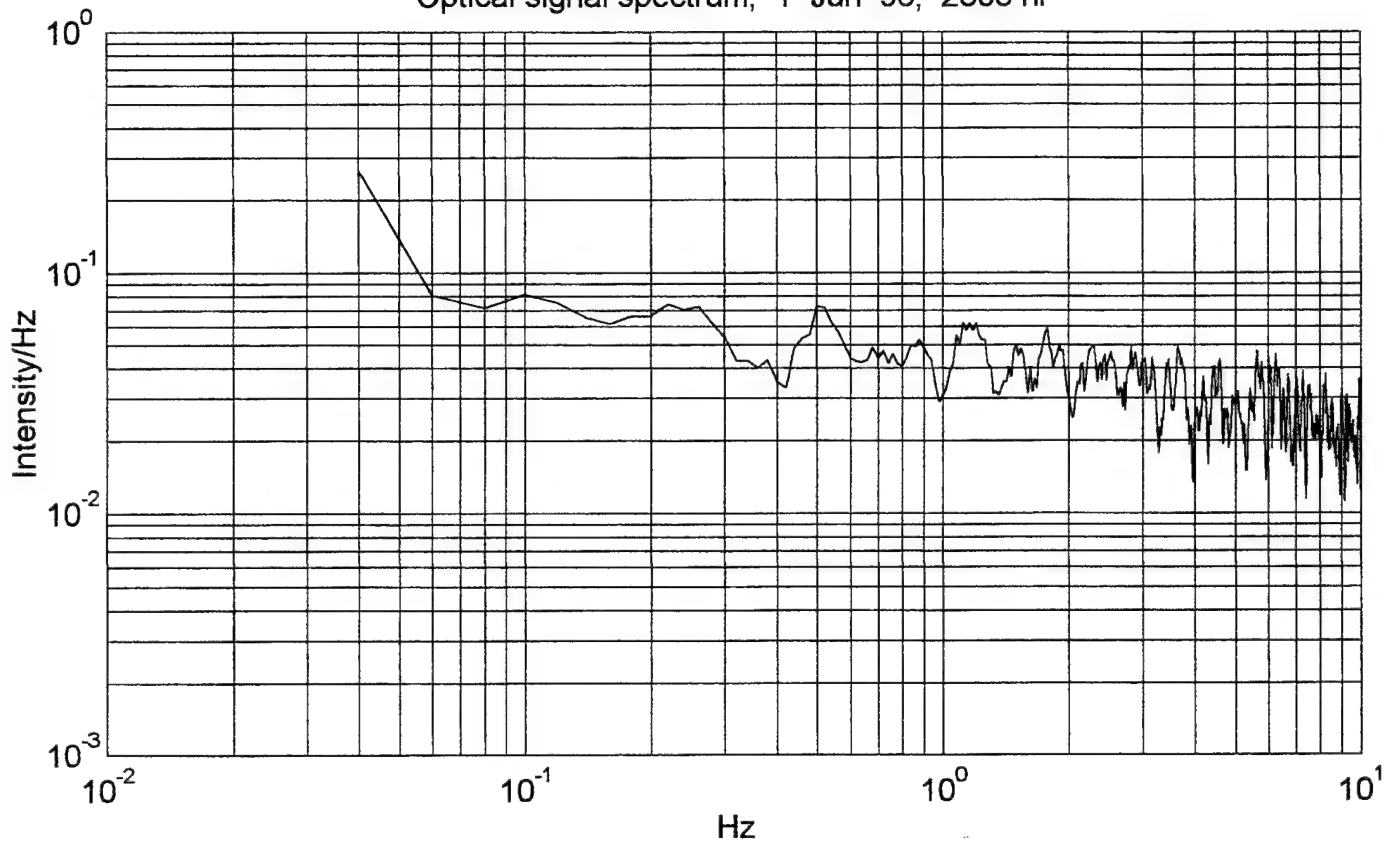
Optical signal spectrum, 1 Jun 96, 2243 hr



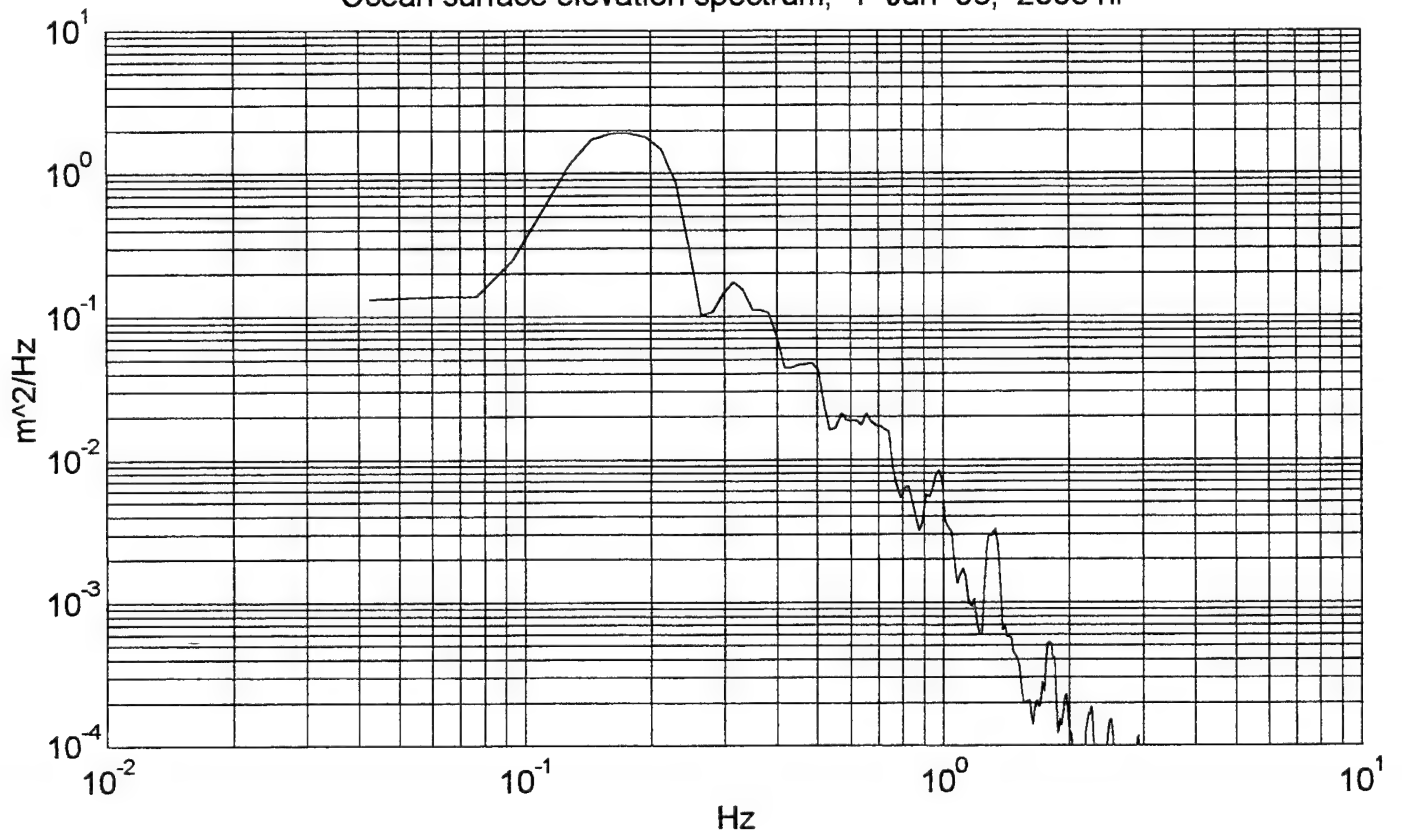
Ocean surface elevation spectrum, 1 Jun 96, 2243 hr



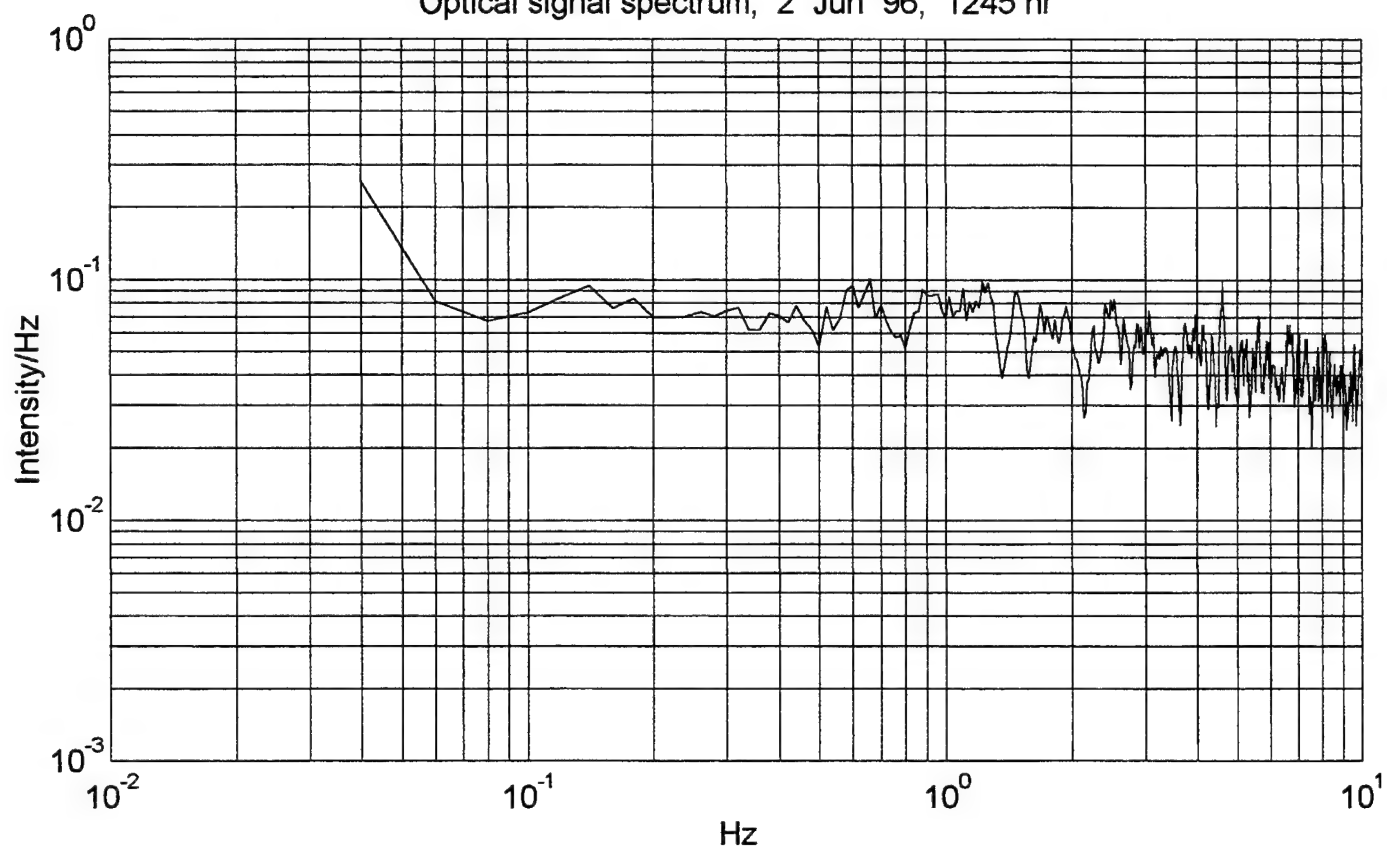
Optical signal spectrum, 1 Jun 96, 2308 hr



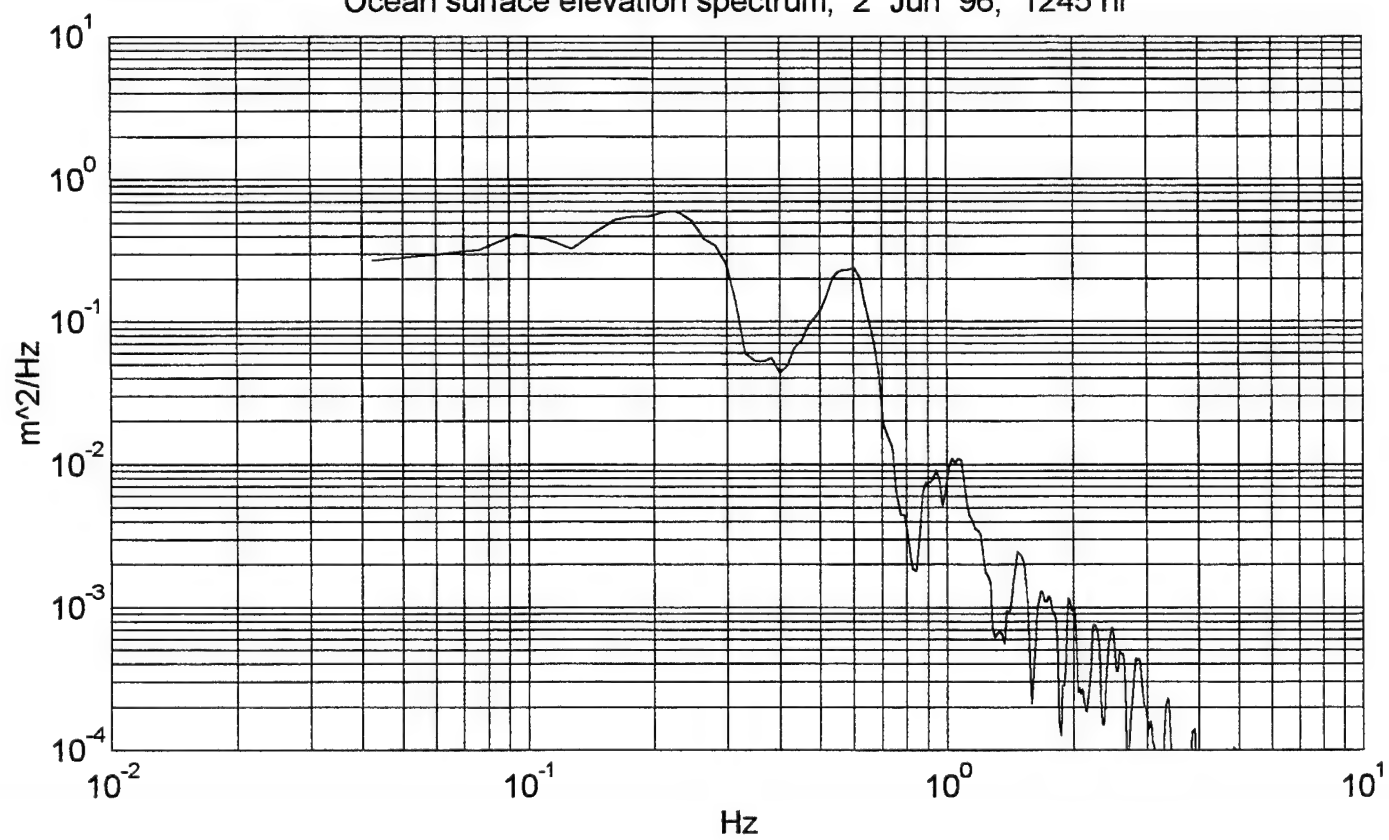
Ocean surface elevation spectrum, 1 Jun 96, 2308 hr



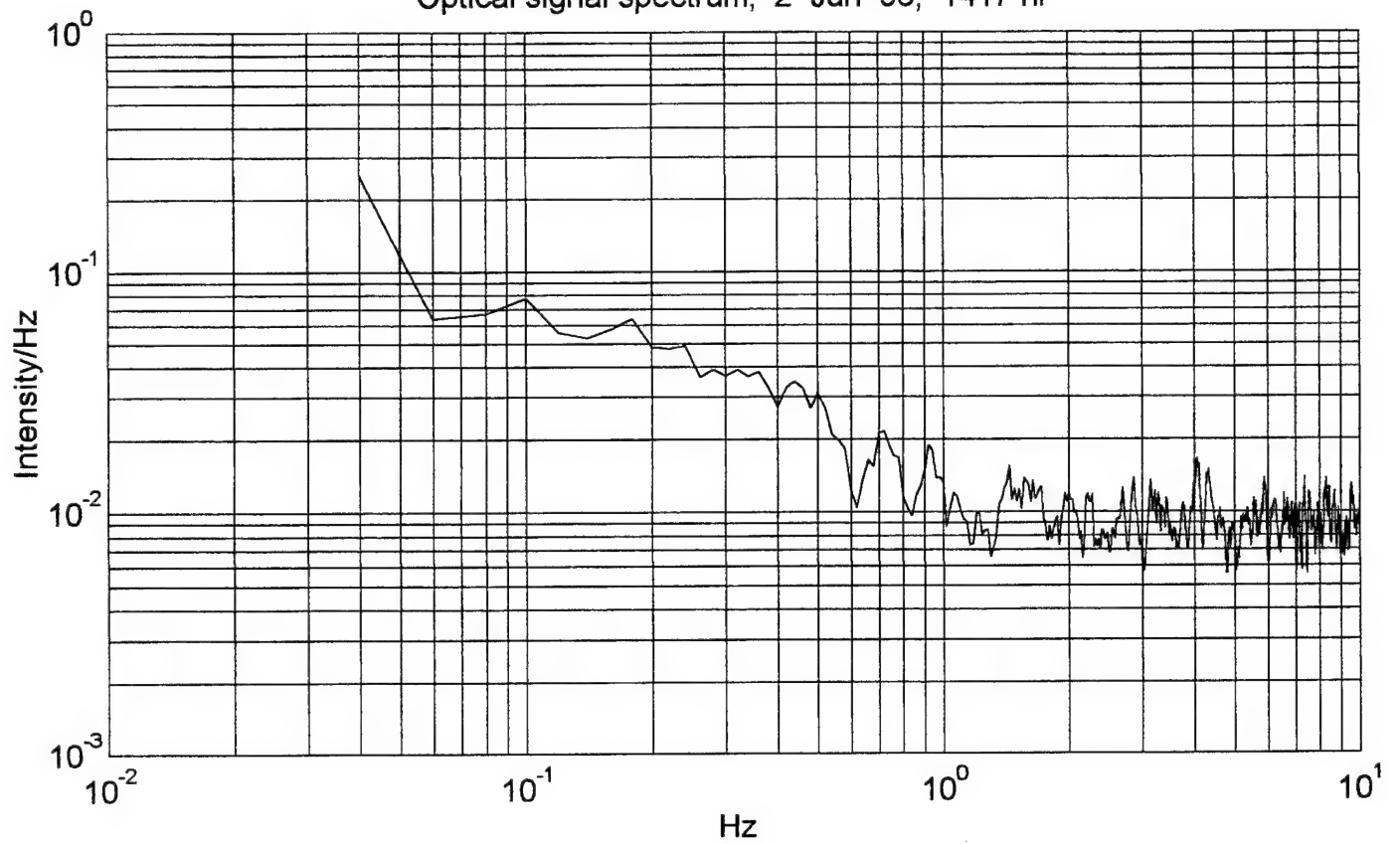
Optical signal spectrum, 2 Jun 96, 1245 hr



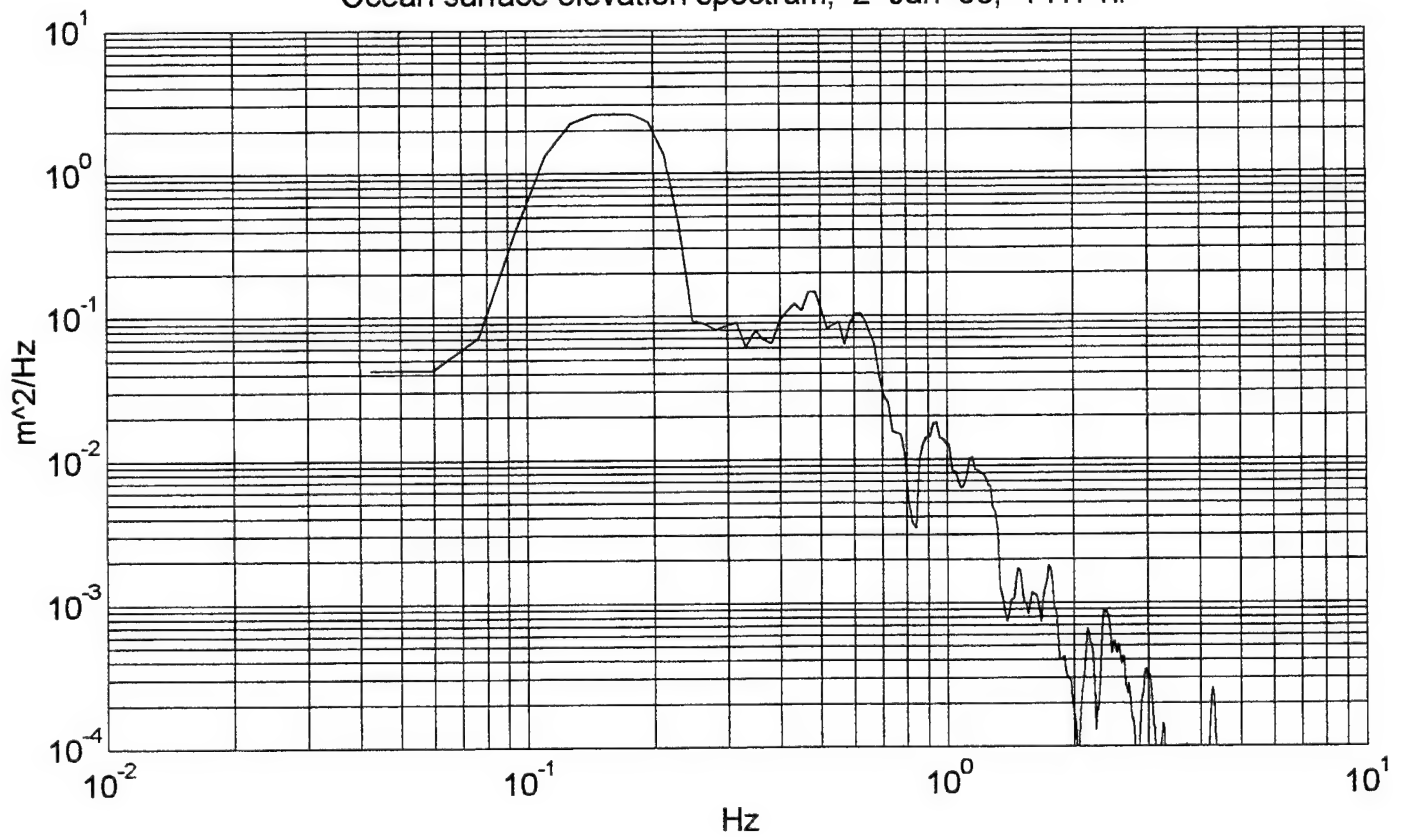
Ocean surface elevation spectrum, 2 Jun 96, 1245 hr



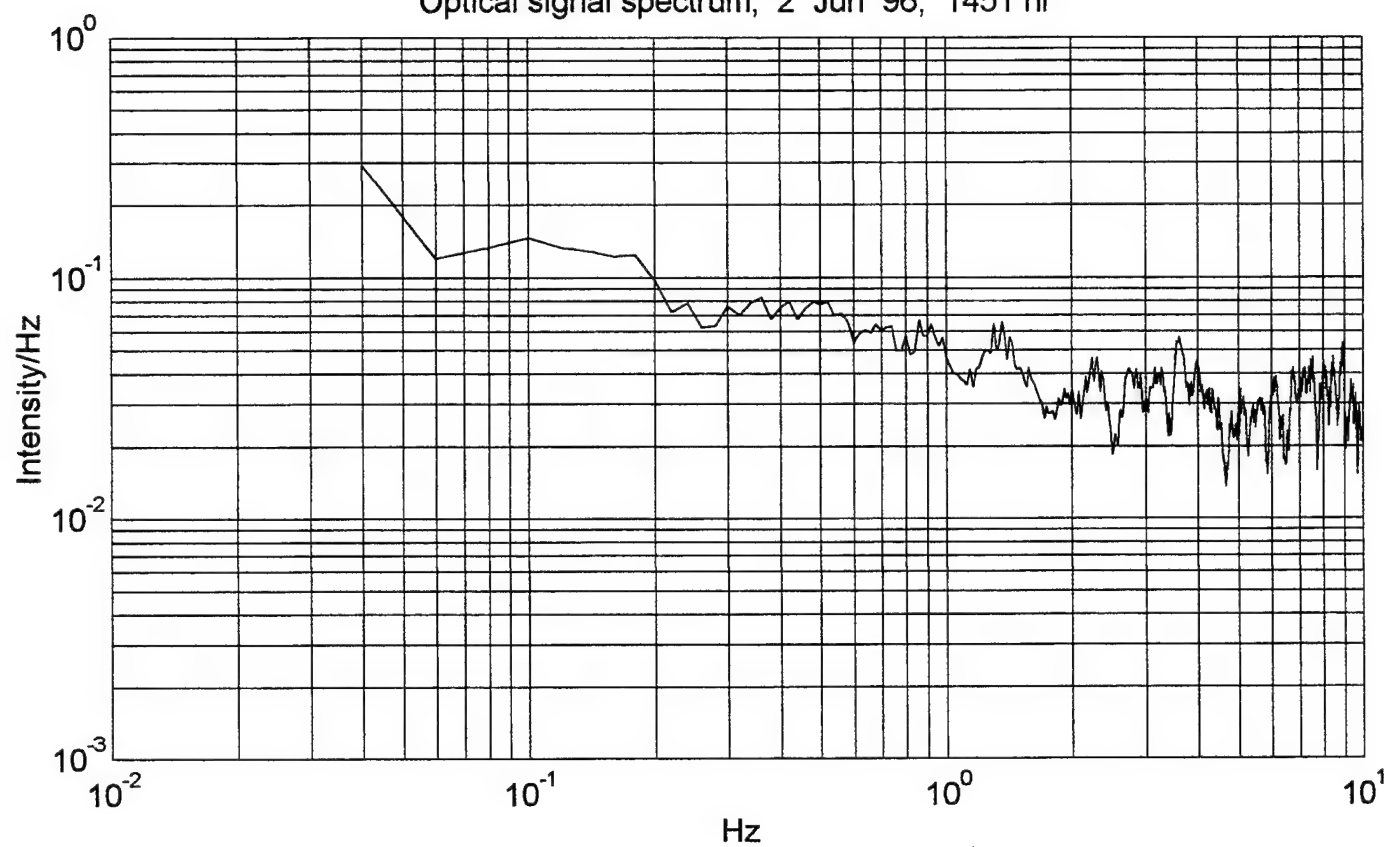
Optical signal spectrum, 2 Jun 96, 1417 hr



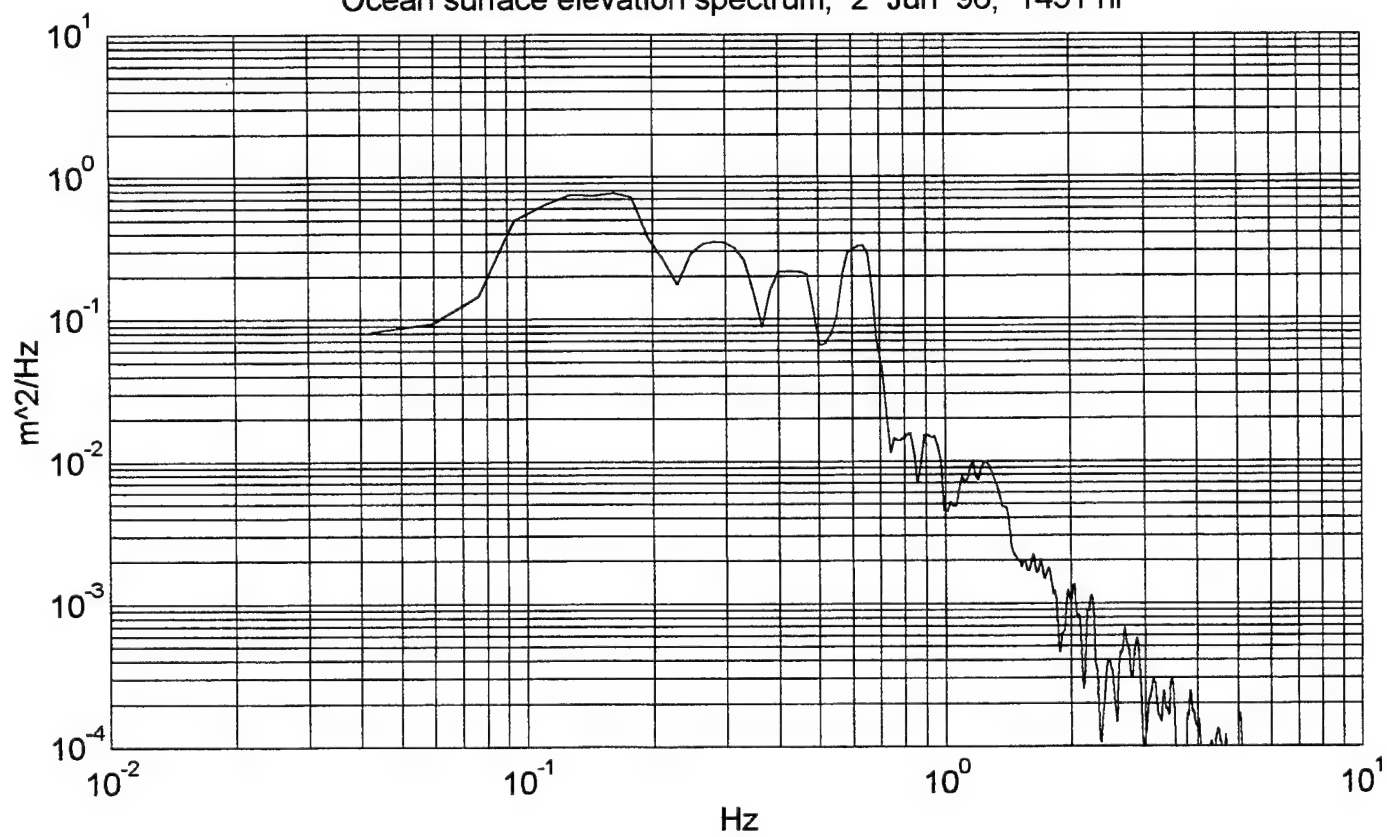
Ocean surface elevation spectrum, 2 Jun 96, 1417 hr



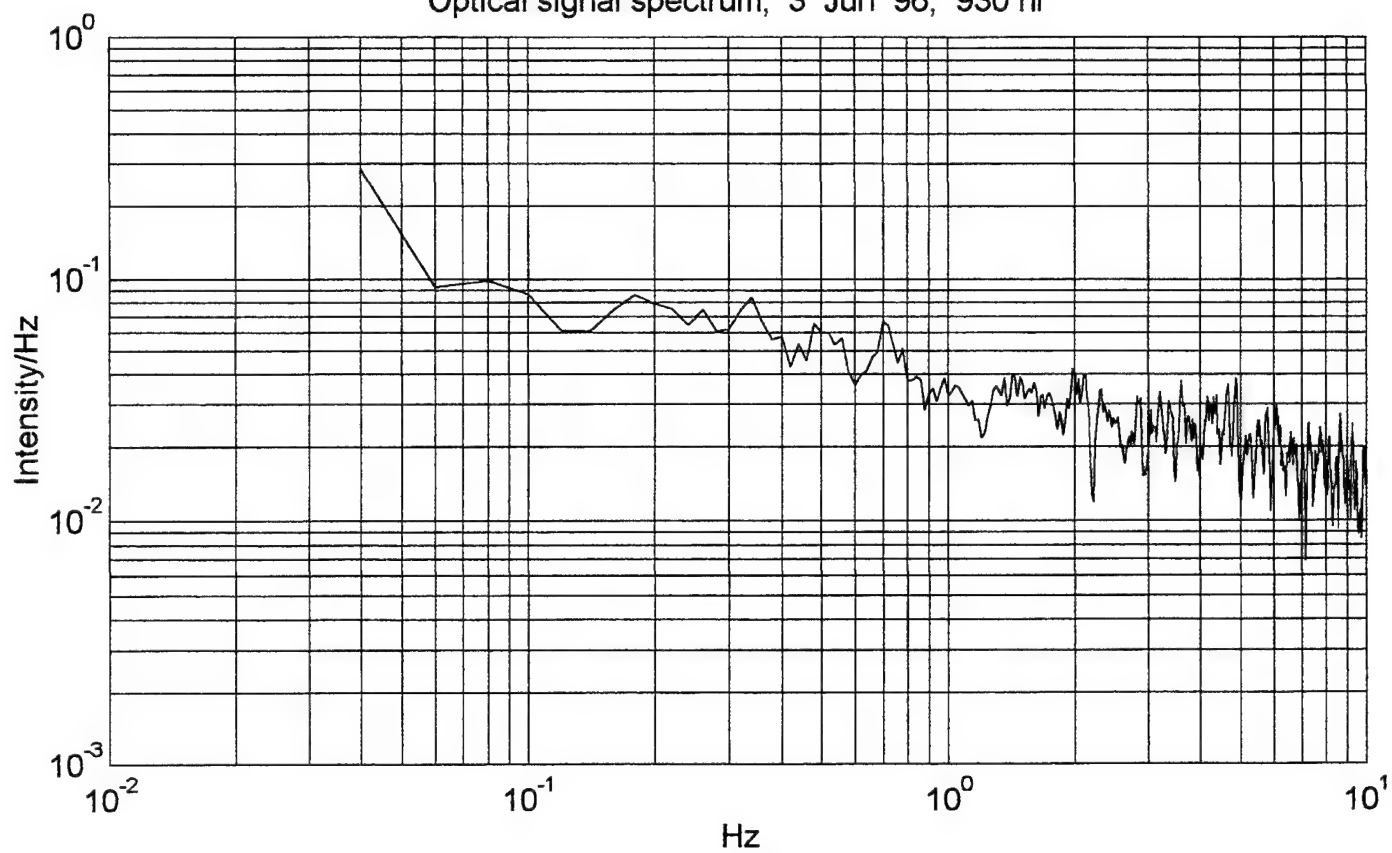
Optical signal spectrum, 2 Jun 96, 1451 hr



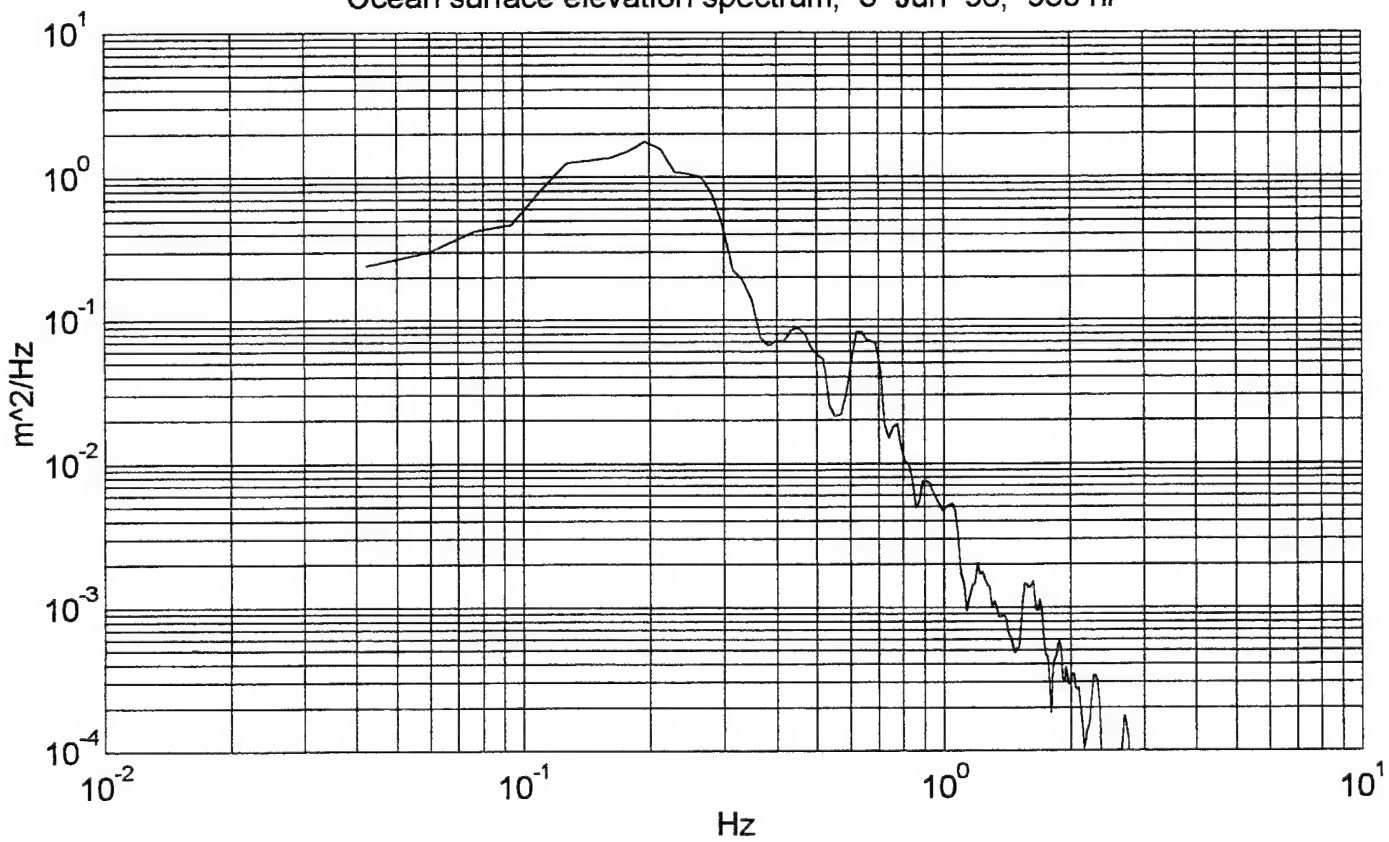
Ocean surface elevation spectrum, 2 Jun 96, 1451 hr



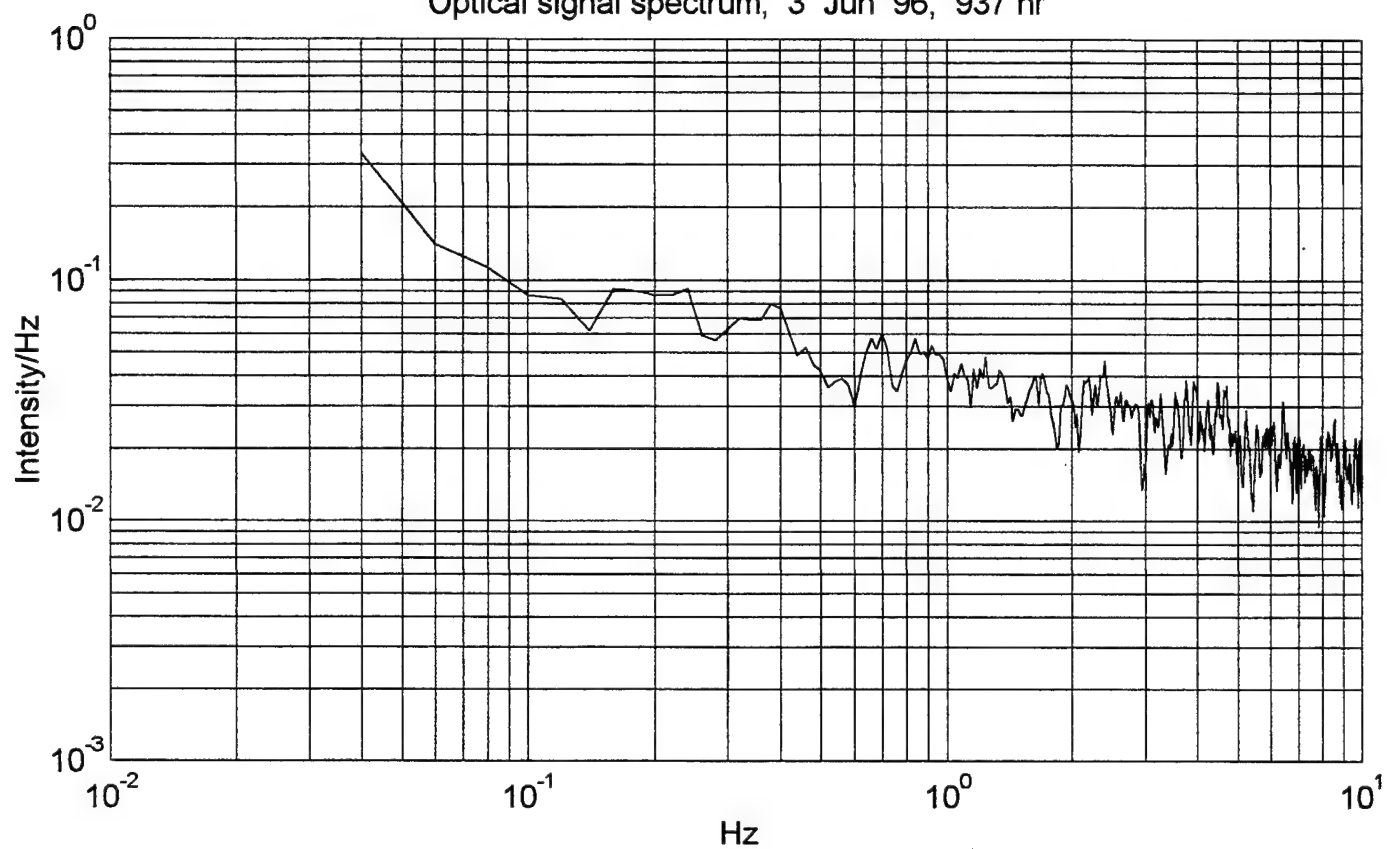
Optical signal spectrum, 3 Jun 96, 930 hr



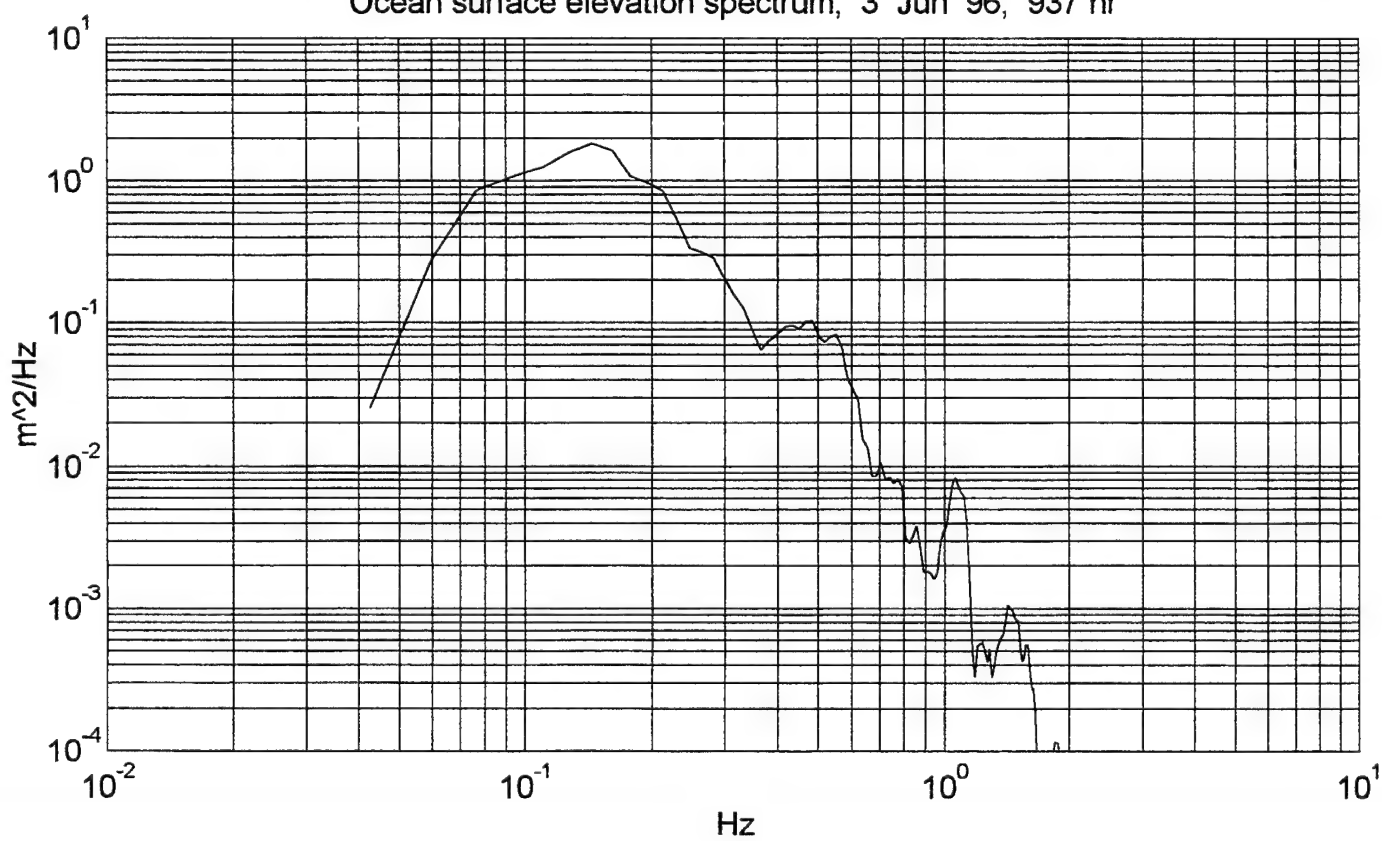
Ocean surface elevation spectrum, 3 Jun 96, 930 hr



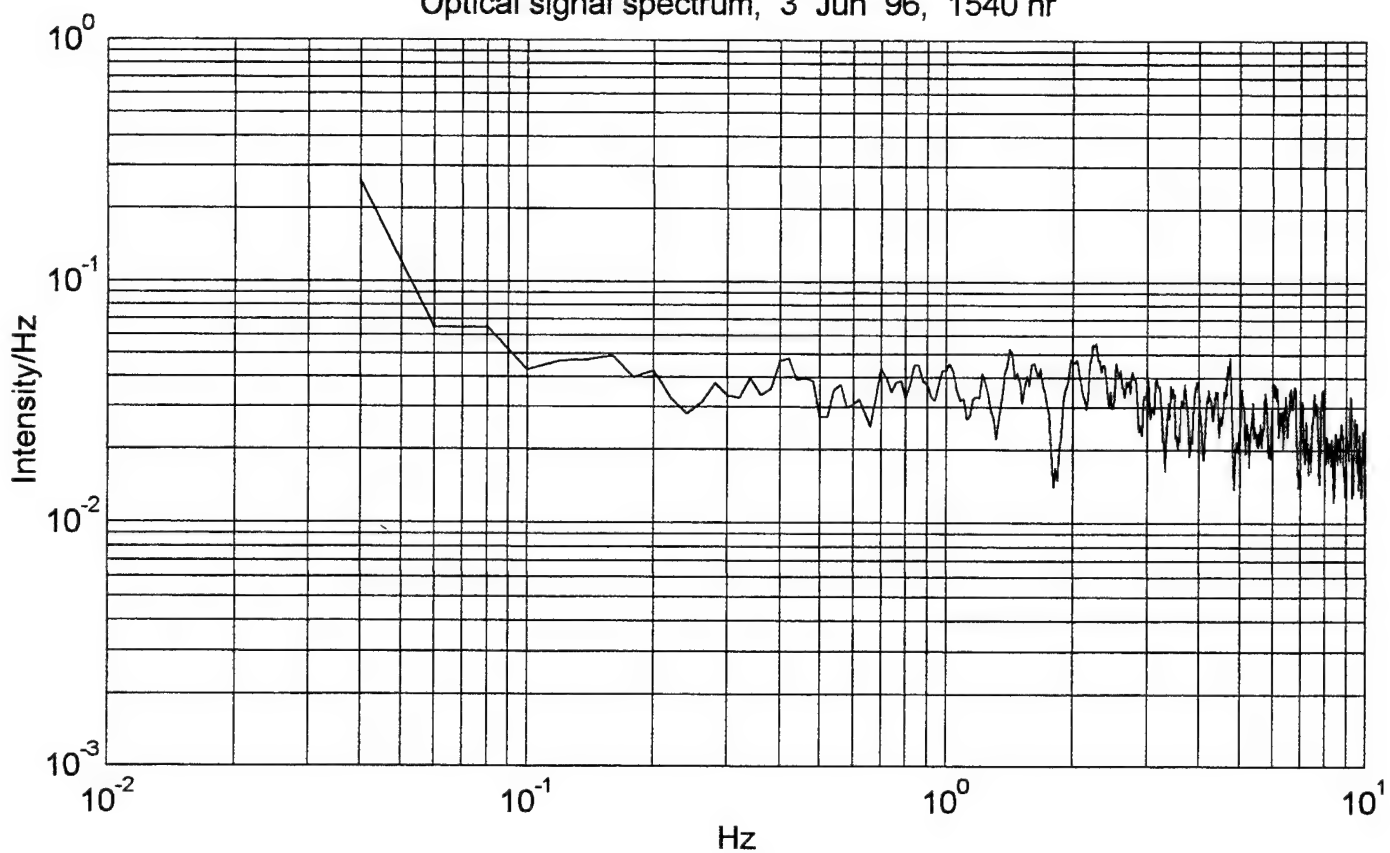
Optical signal spectrum, 3 Jun 96, 937 hr



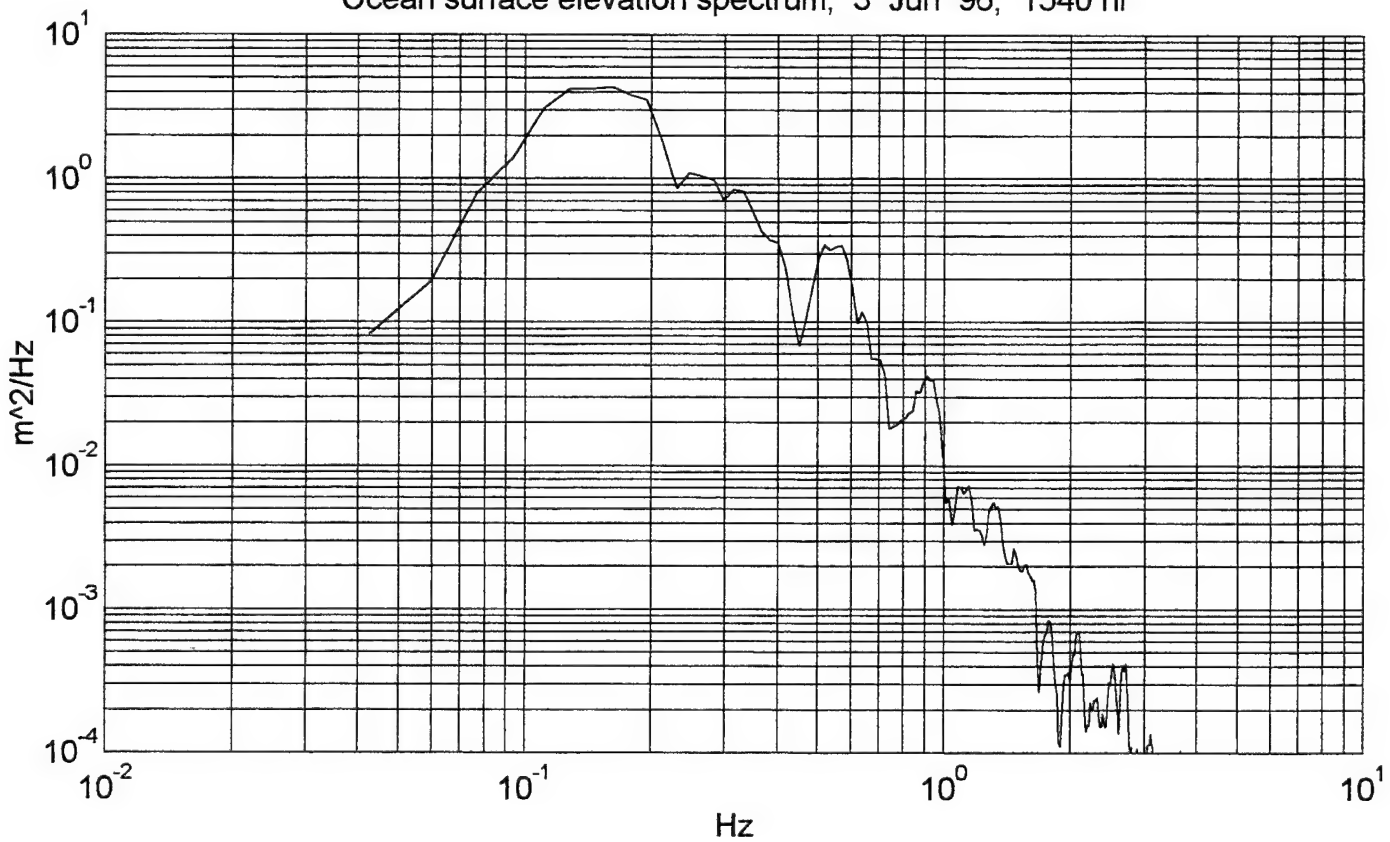
Ocean surface elevation spectrum, 3 Jun 96, 937 hr



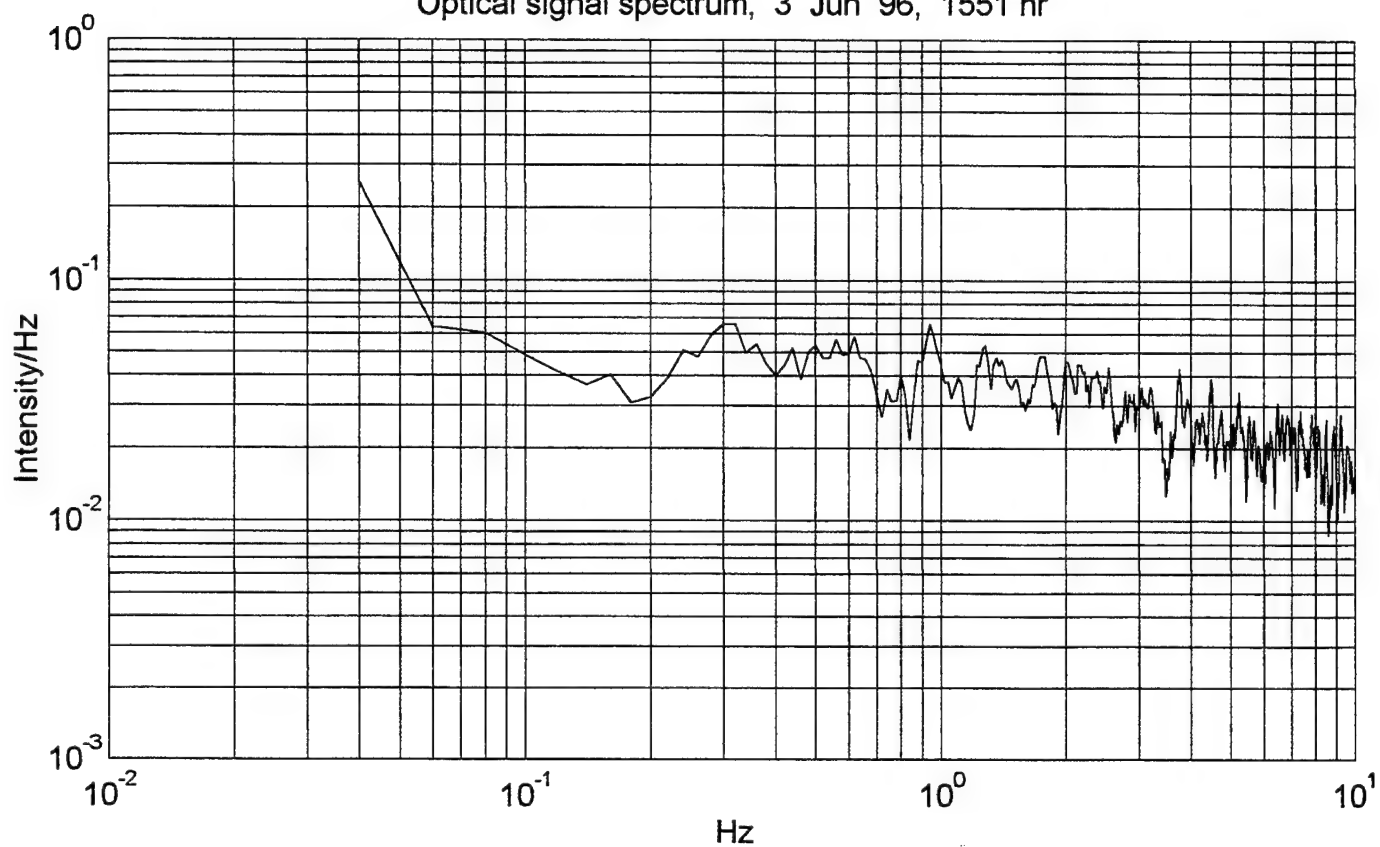
Optical signal spectrum, 3 Jun 96, 1540 hr



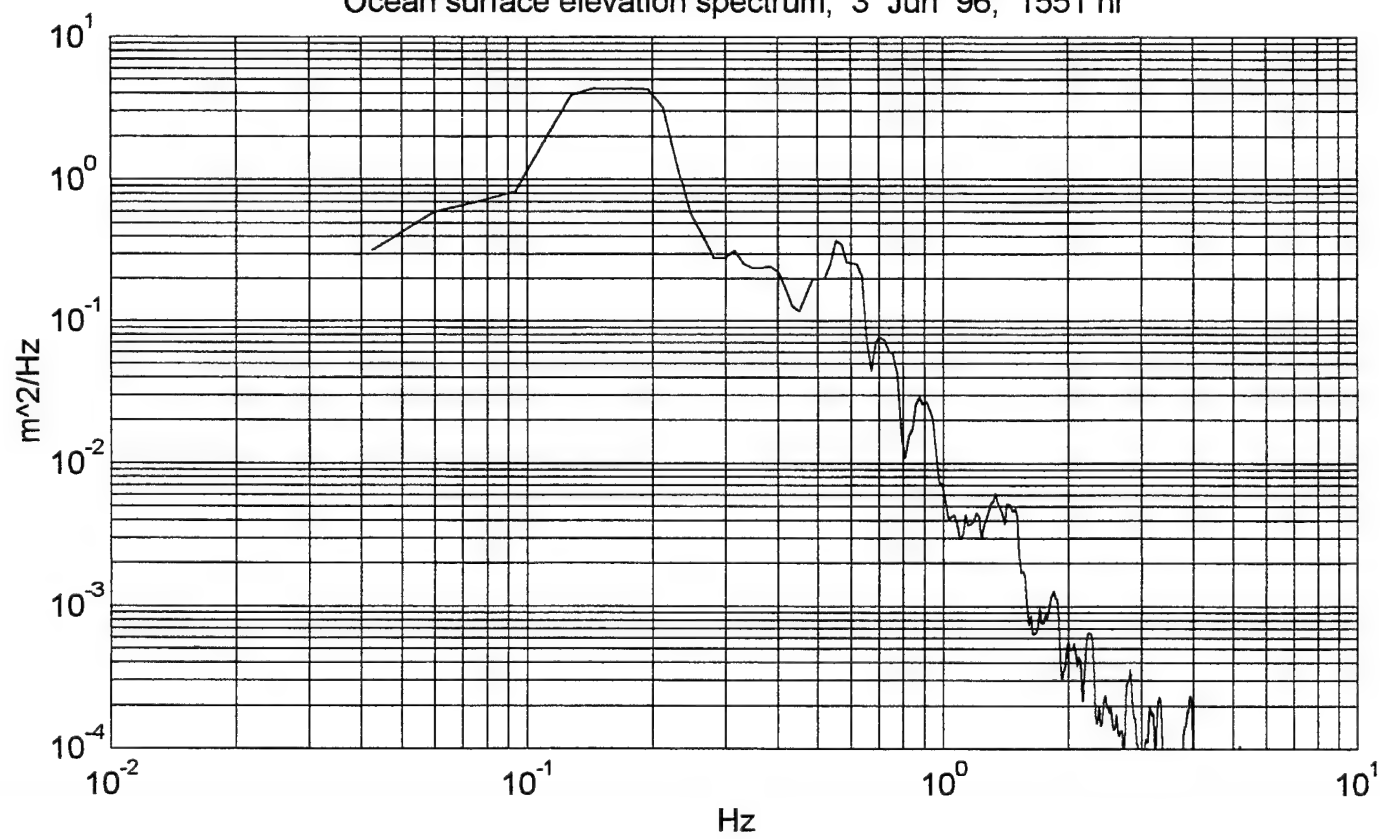
Ocean surface elevation spectrum, 3 Jun 96, 1540 hr



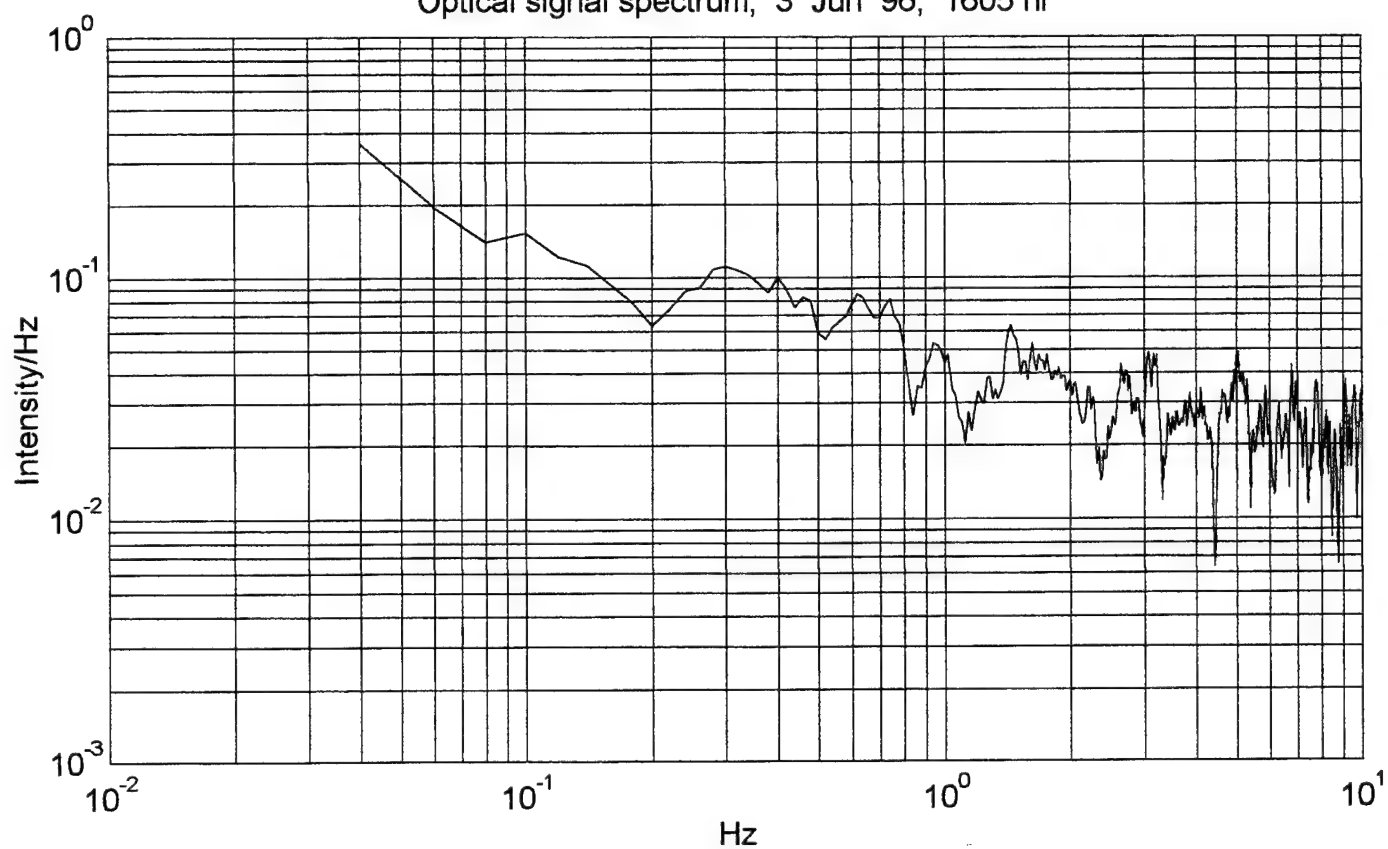
Optical signal spectrum, 3 Jun 96, 1551 hr



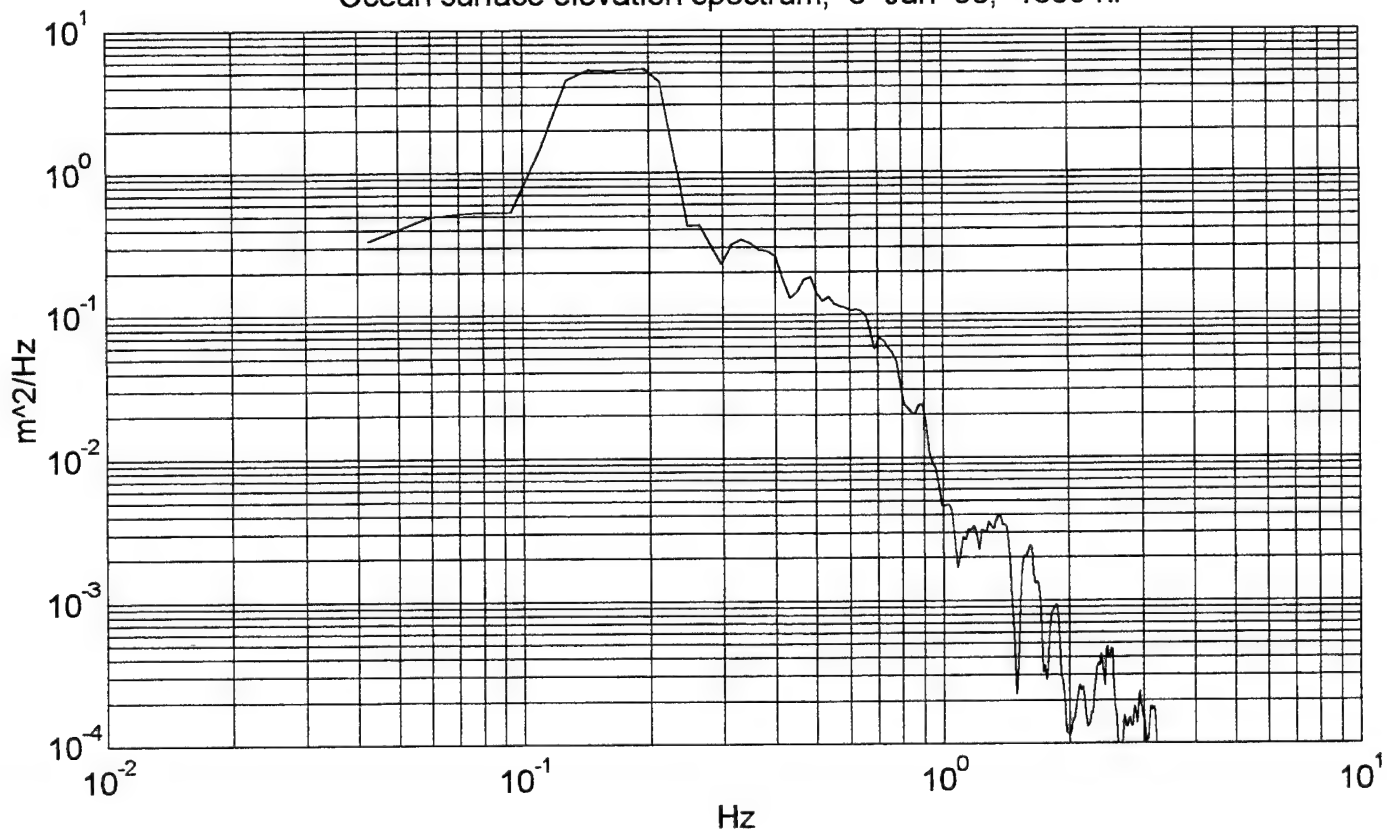
Ocean surface elevation spectrum, 3 Jun 96, 1551 hr



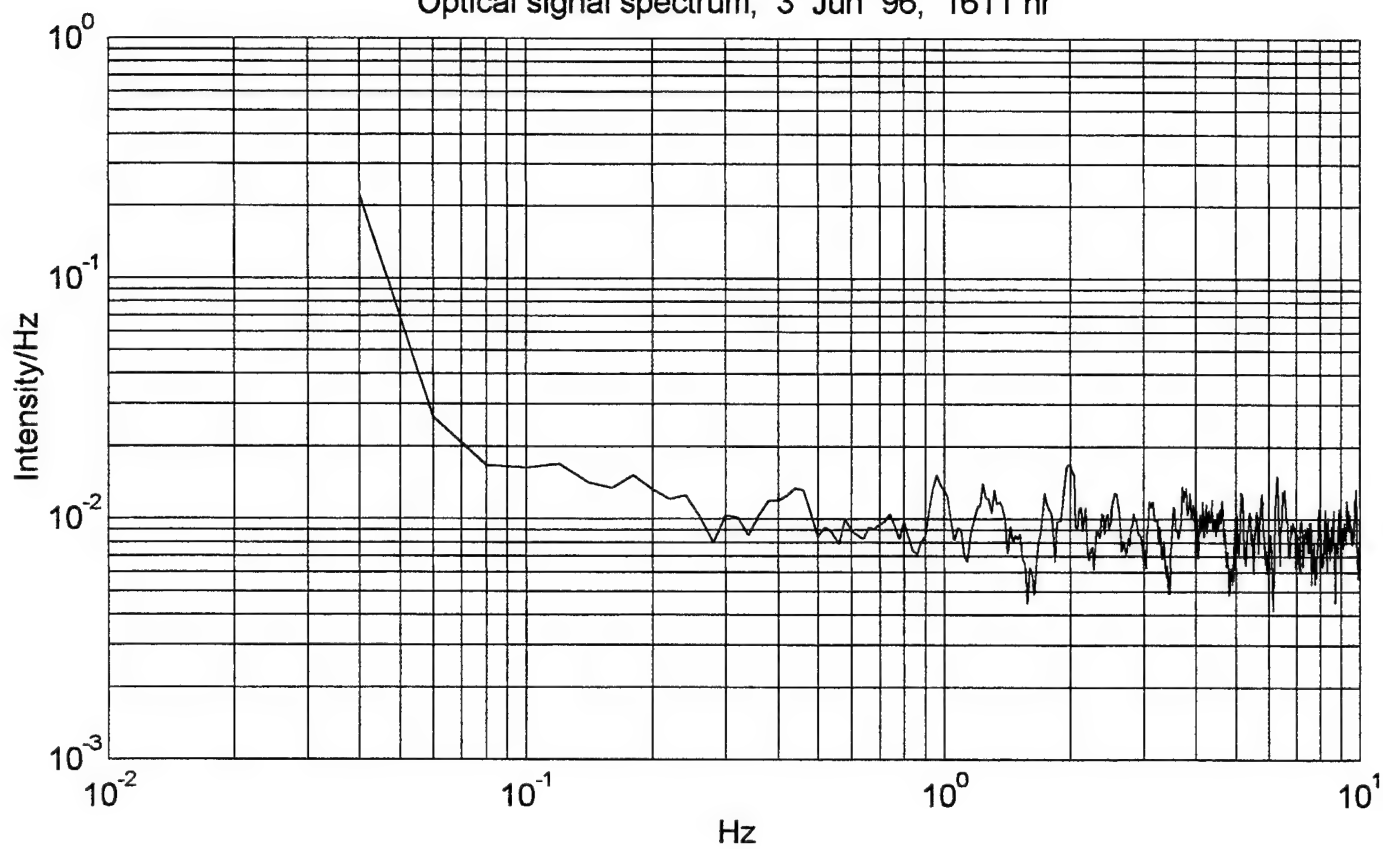
Optical signal spectrum, 3 Jun 96, 1605 hr



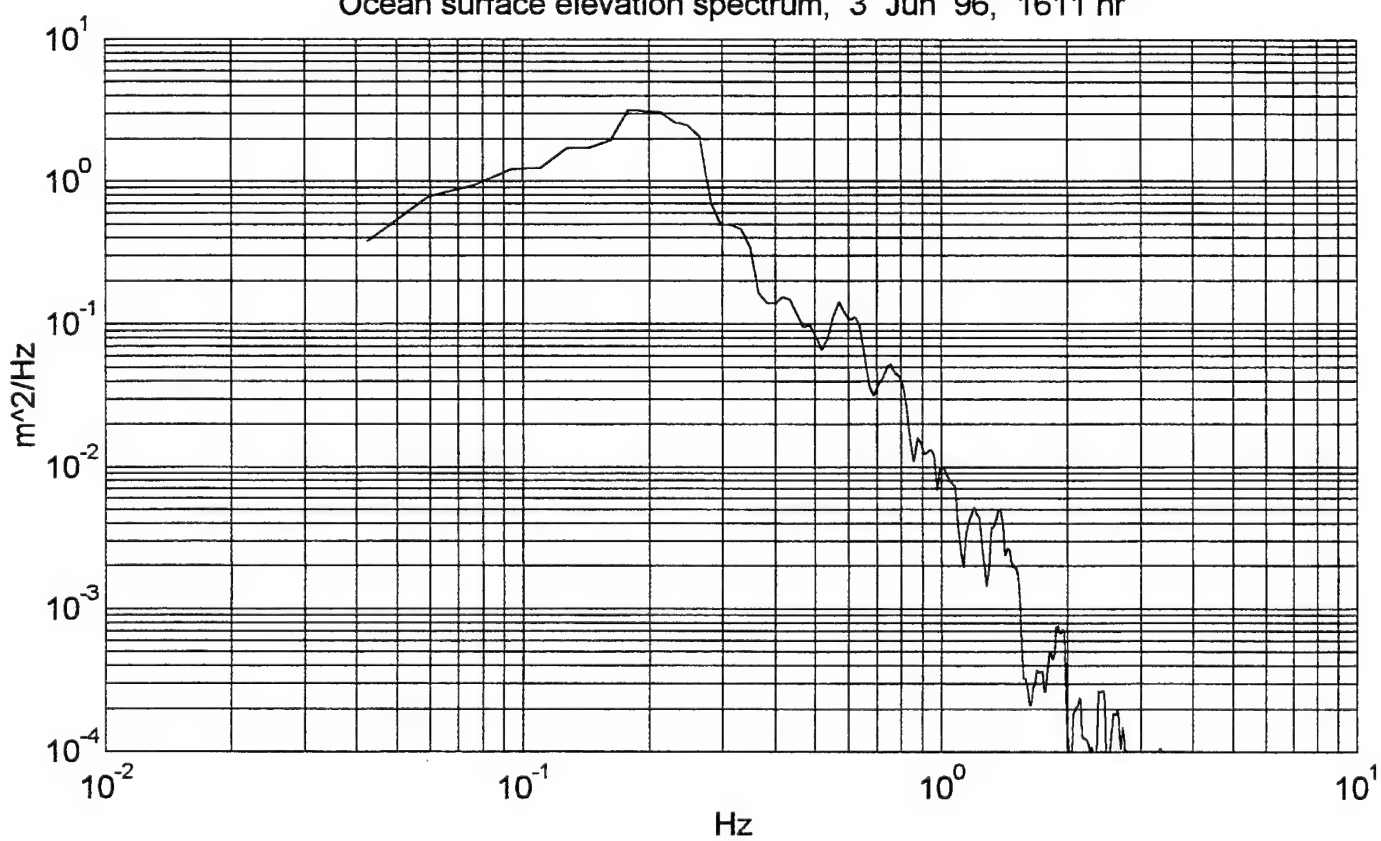
Ocean surface elevation spectrum, 3 Jun 96, 1605 hr



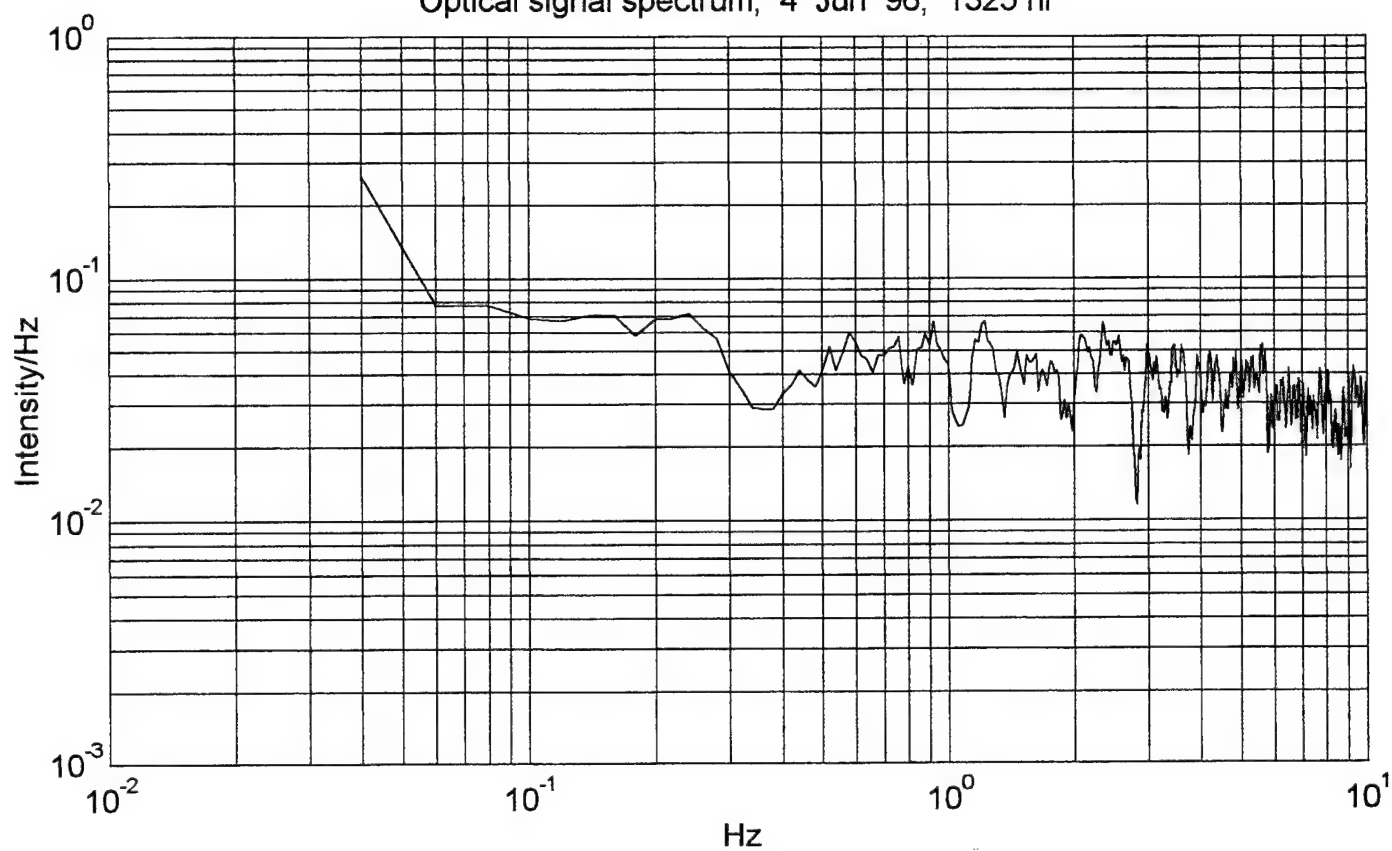
Optical signal spectrum, 3 Jun 96, 1611 hr



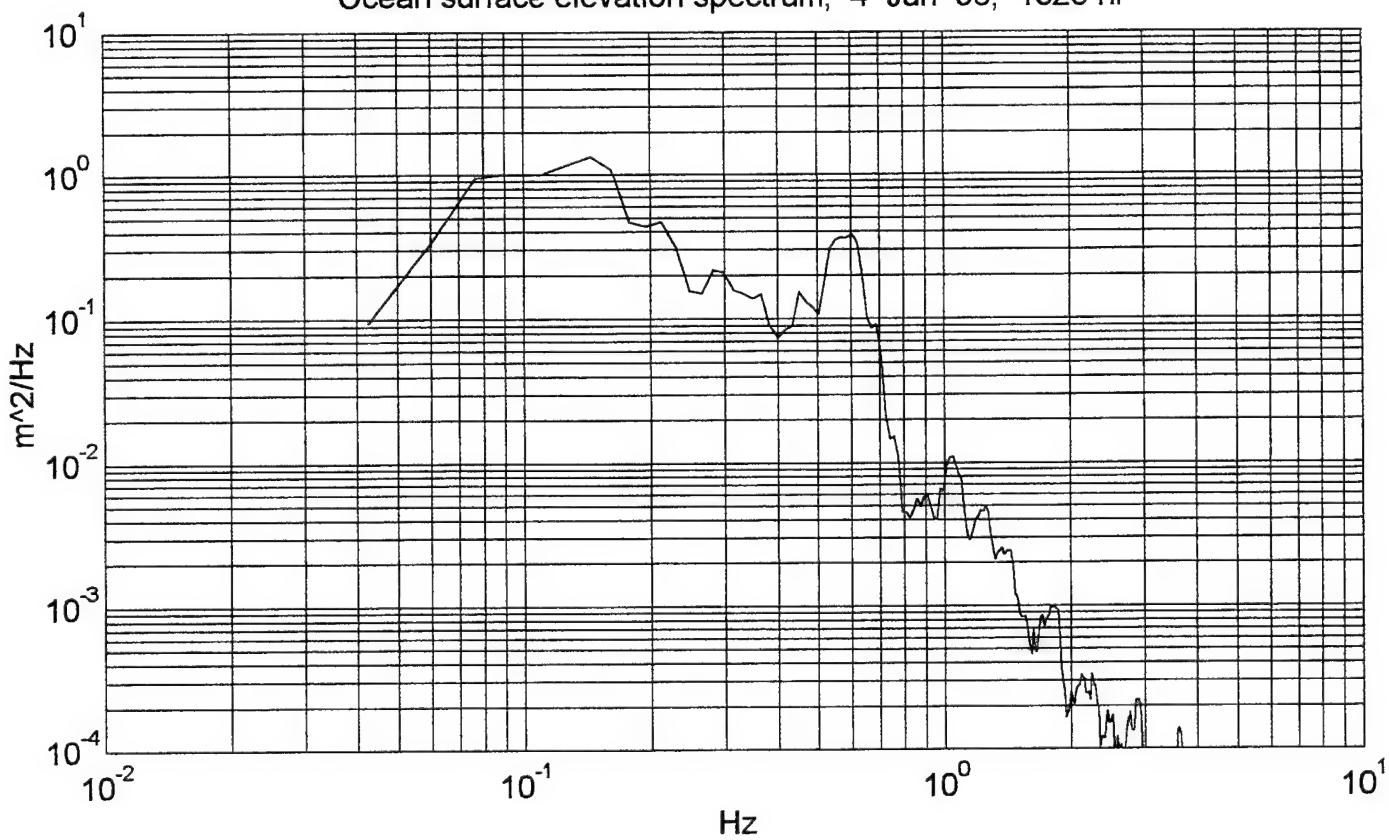
Ocean surface elevation spectrum, 3 Jun 96, 1611 hr



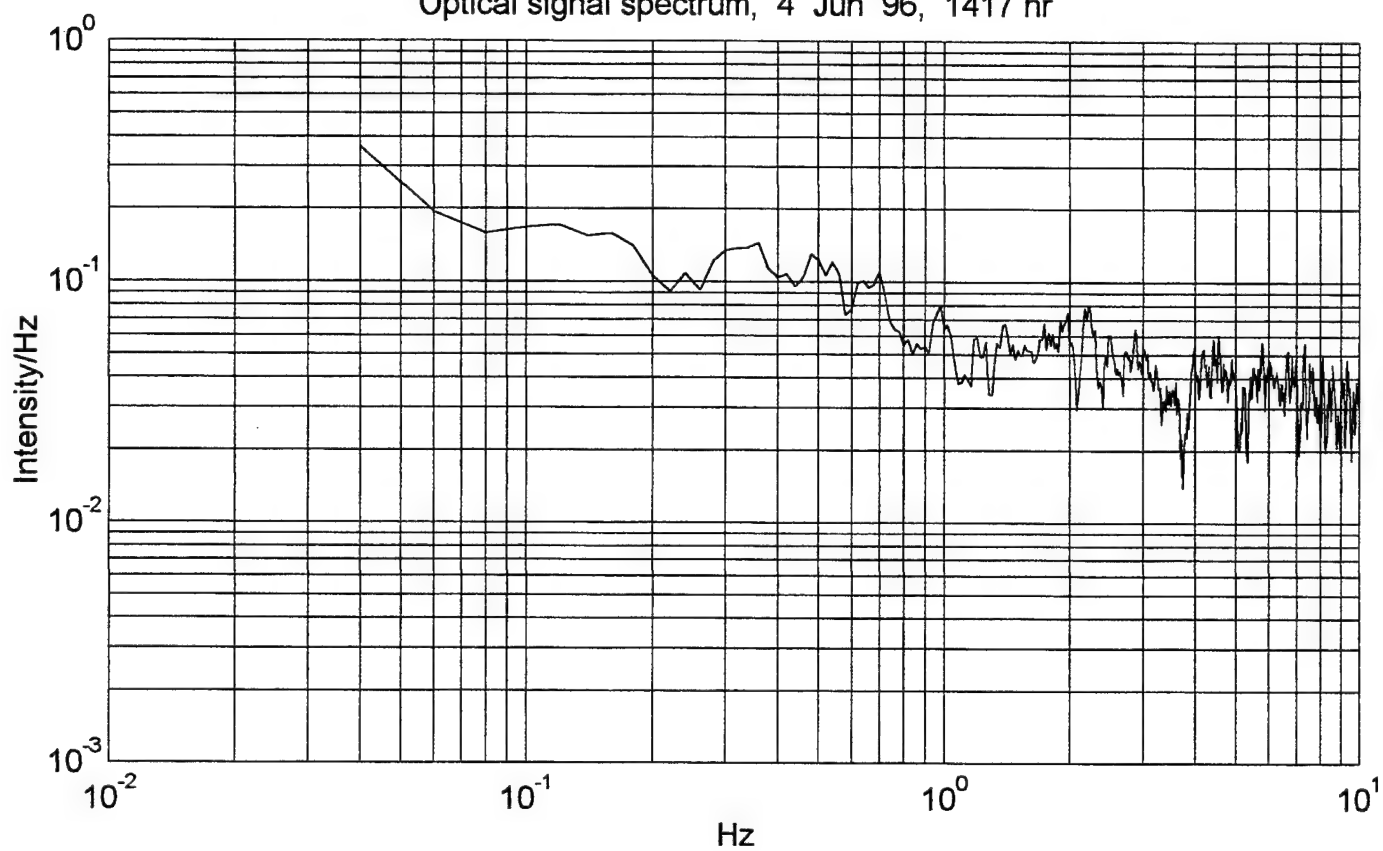
Optical signal spectrum, 4 Jun 96, 1325 hr



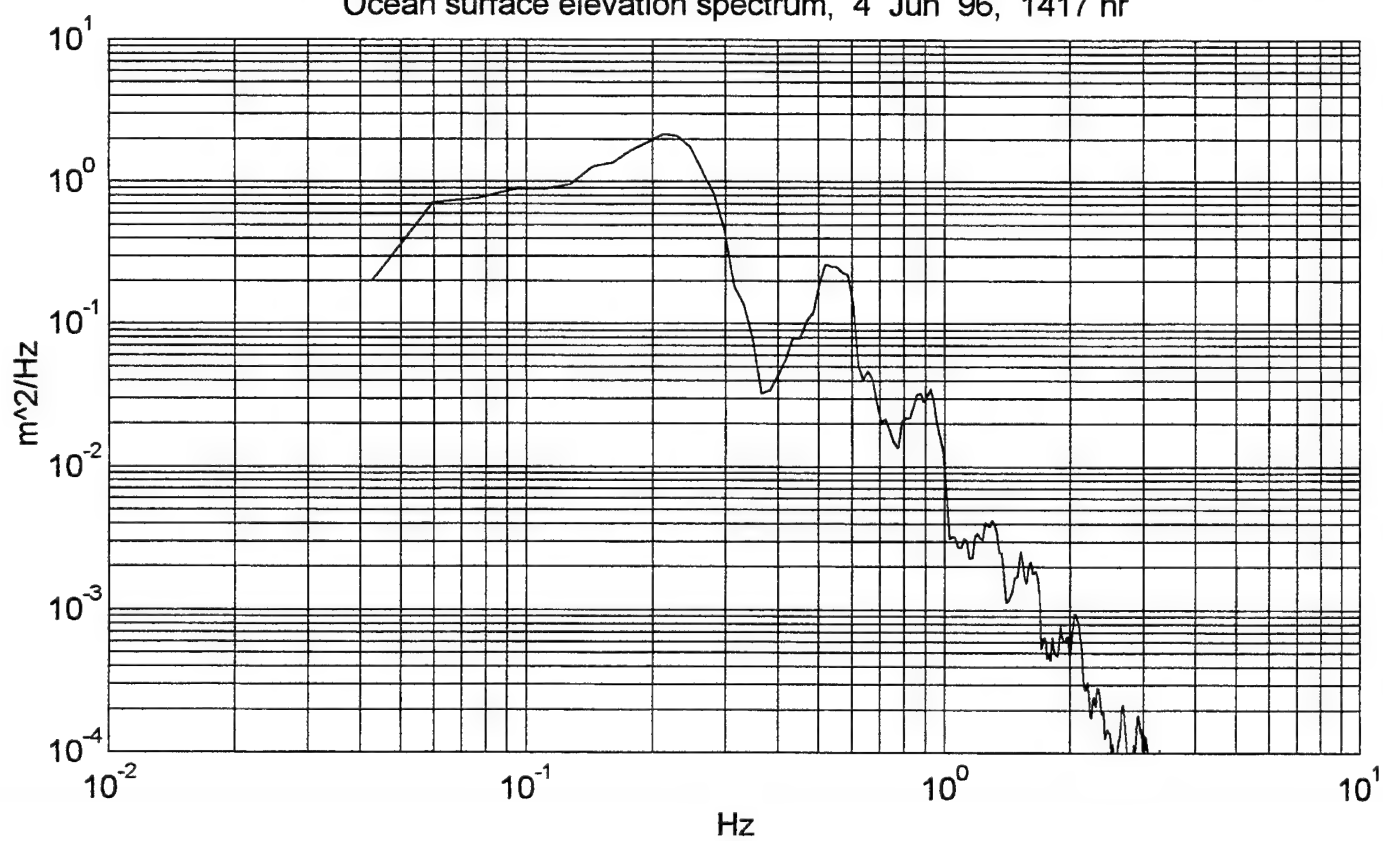
Ocean surface elevation spectrum, 4 Jun 96, 1325 hr



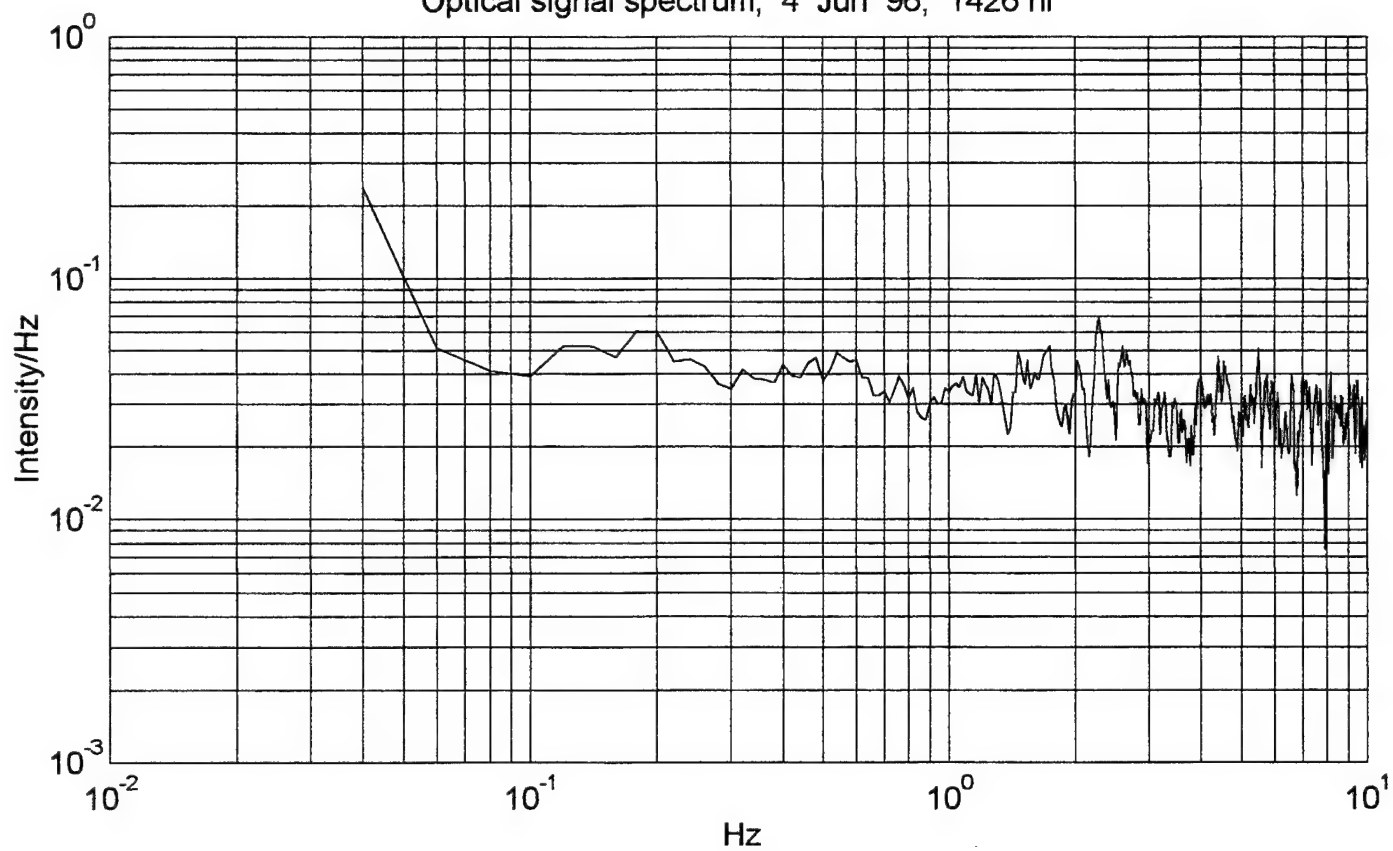
Optical signal spectrum, 4 Jun 96, 1417 hr



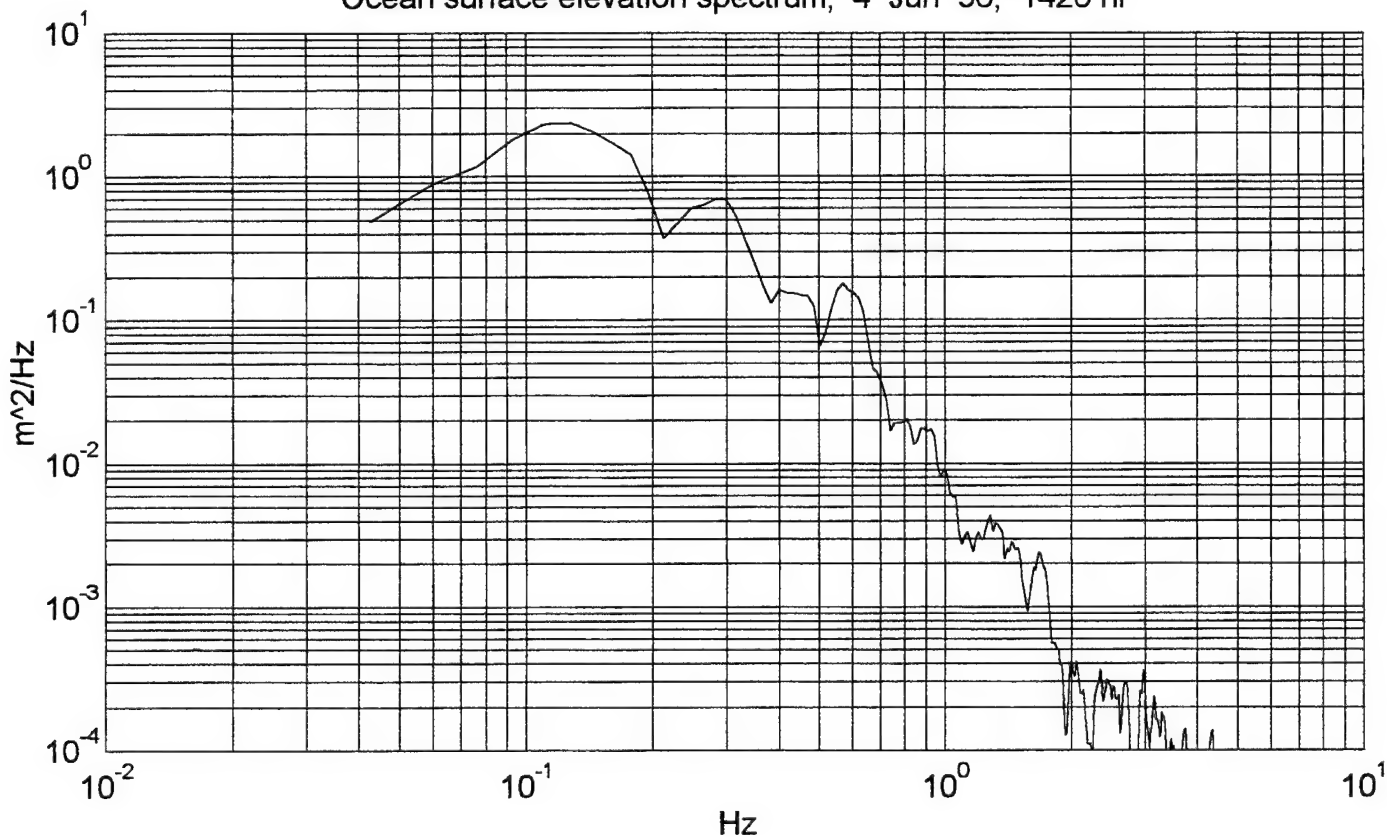
Ocean surface elevation spectrum, 4 Jun 96, 1417 hr



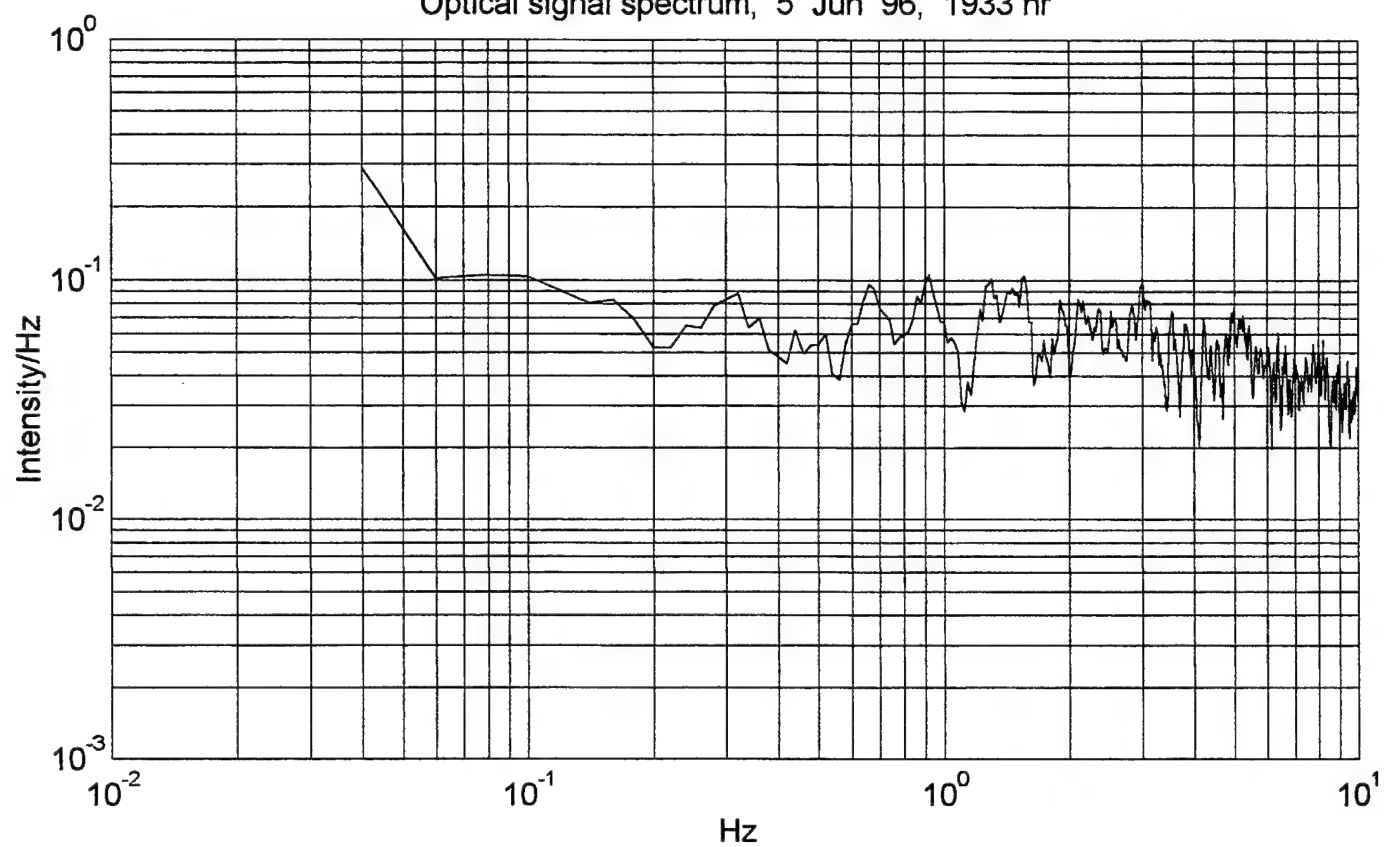
Optical signal spectrum, 4 Jun 96, 1426 hr



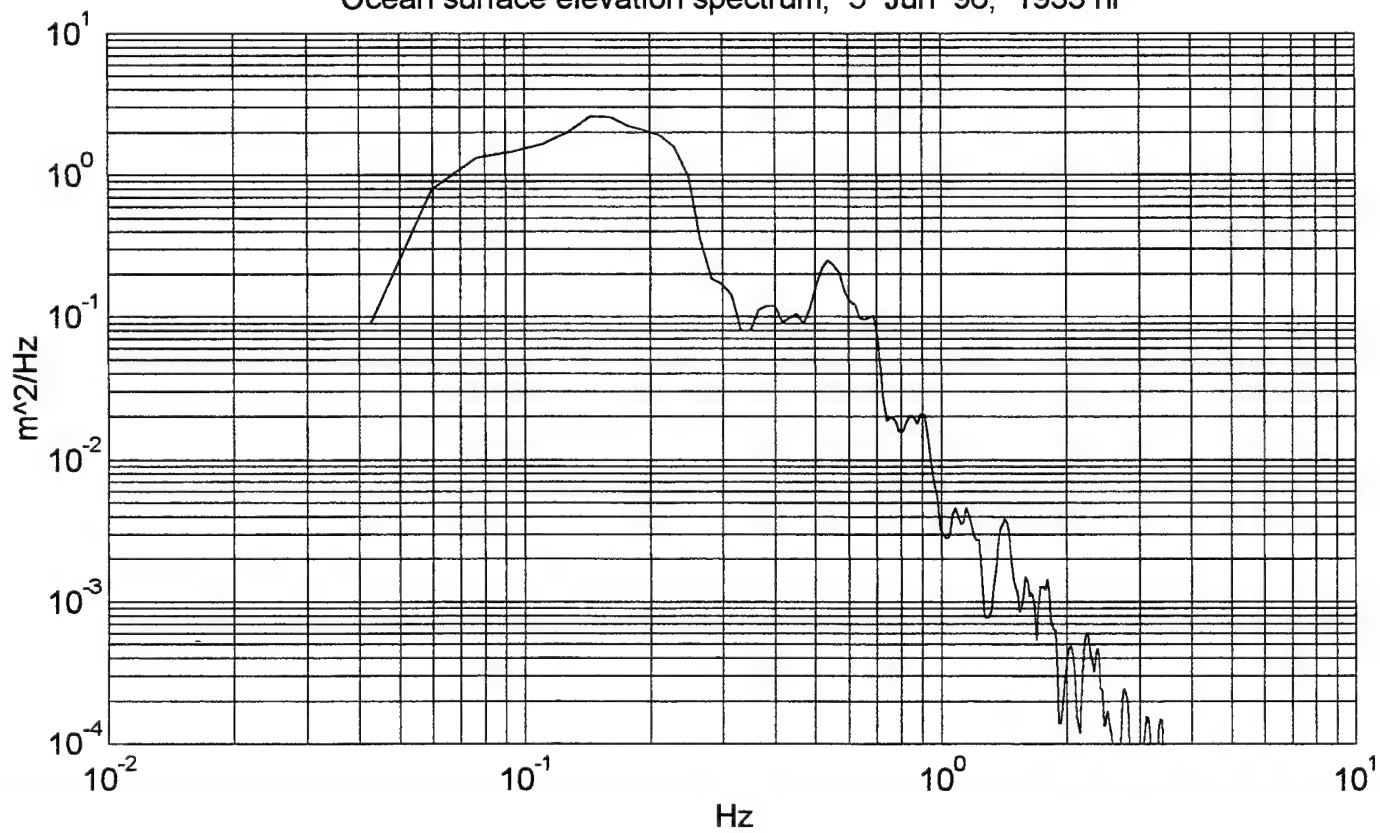
Ocean surface elevation spectrum, 4 Jun 96, 1426 hr



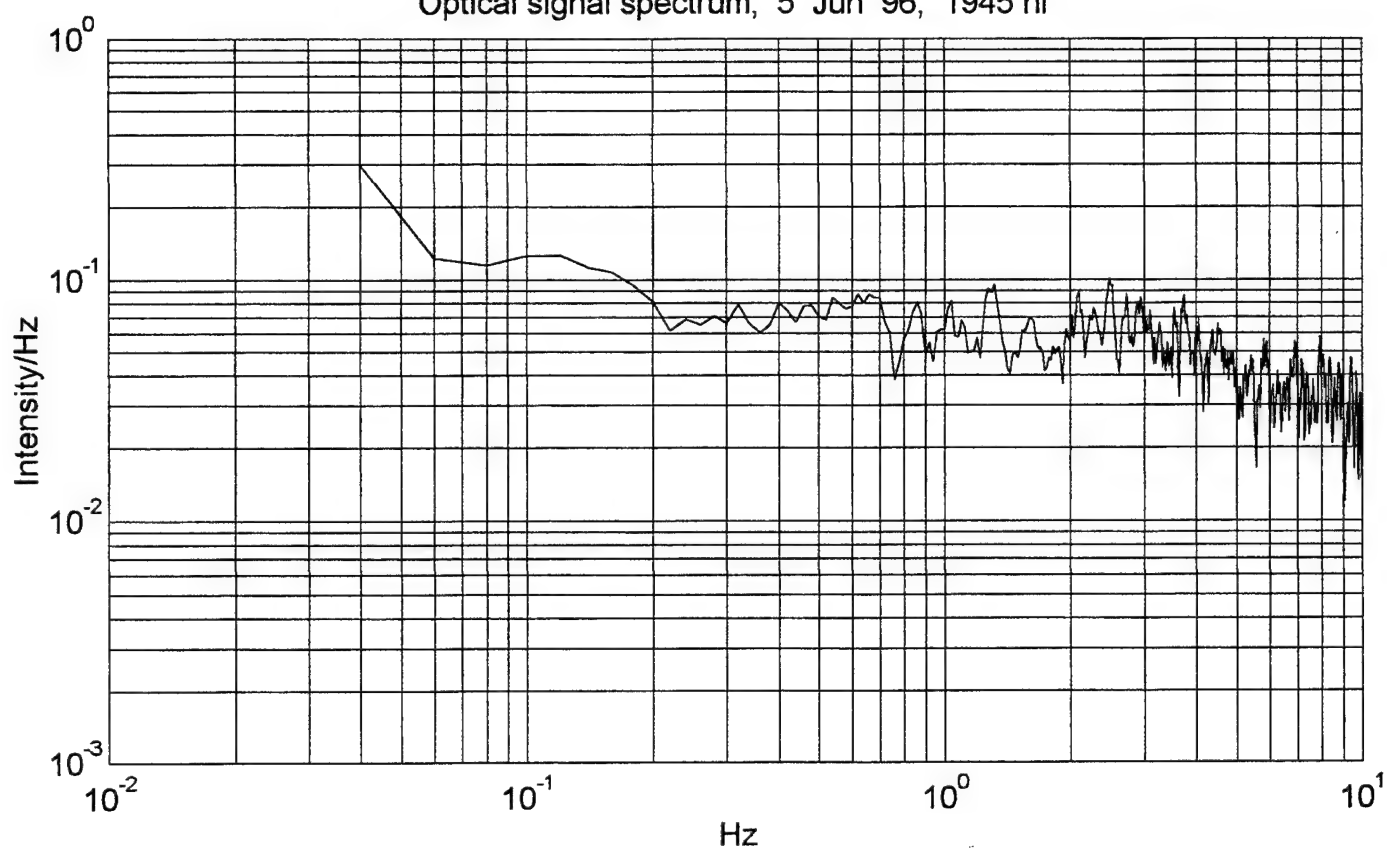
Optical signal spectrum, 5 Jun 96, 1933 hr



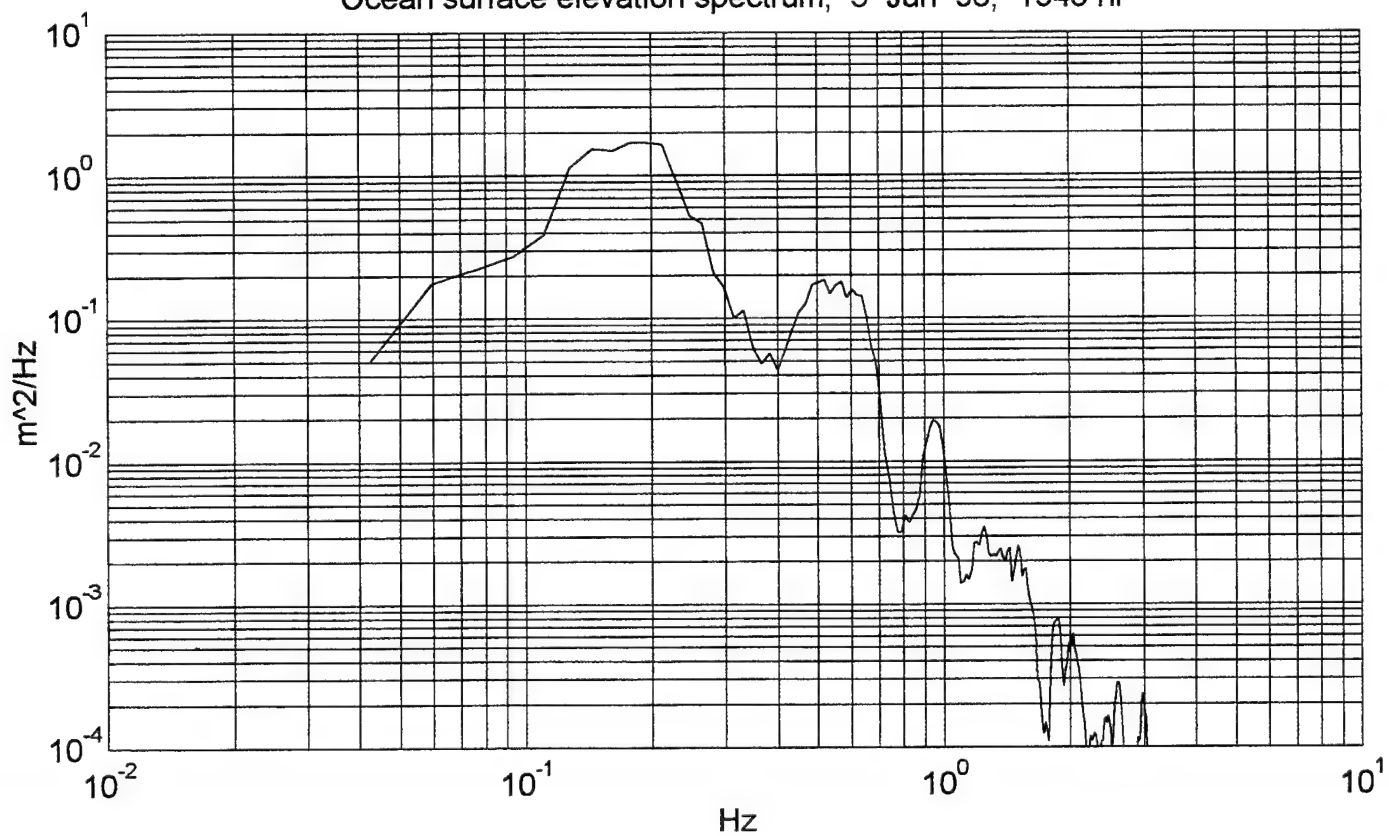
Ocean surface elevation spectrum, 5 Jun 96, 1933 hr



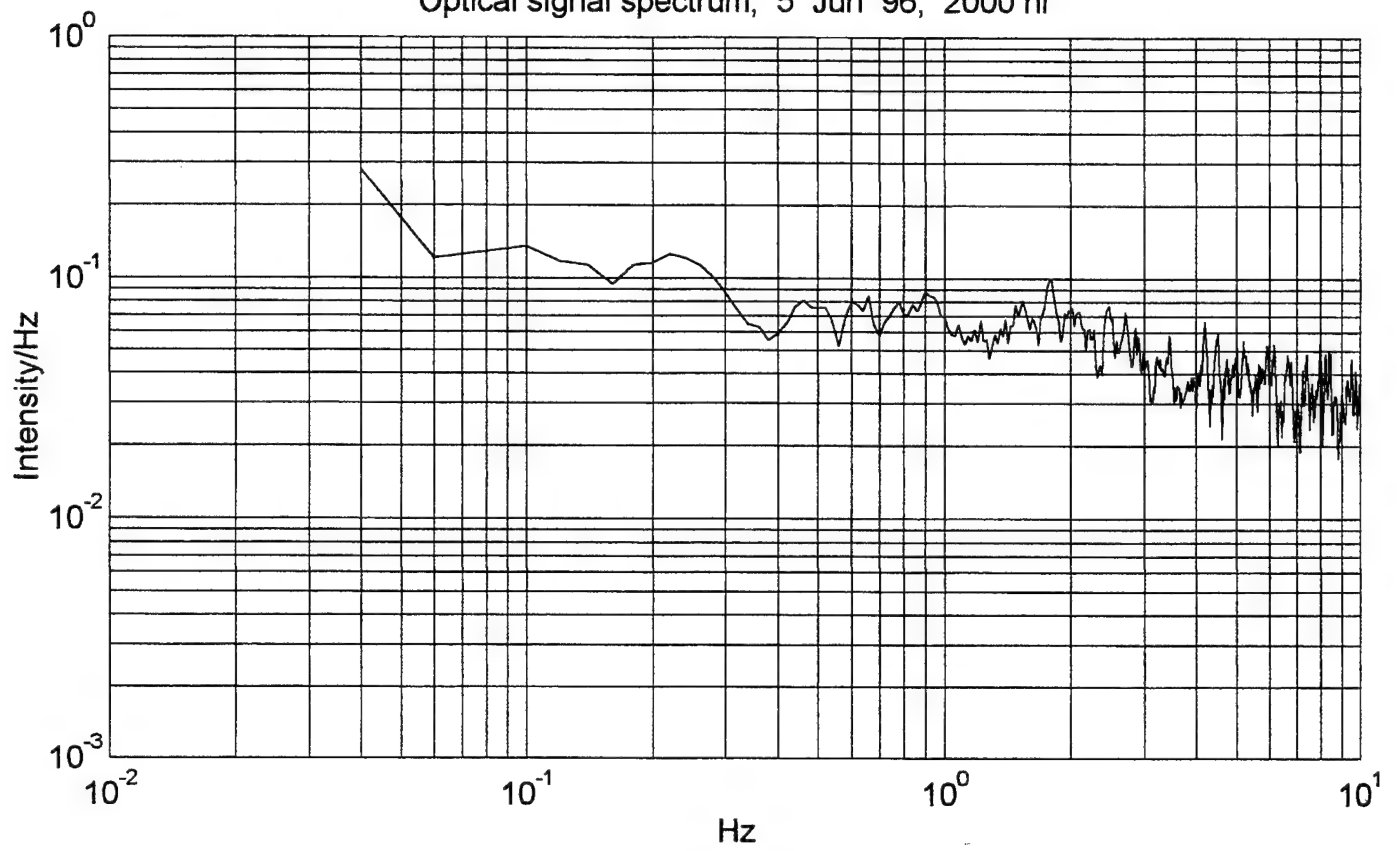
Optical signal spectrum, 5 Jun 96, 1945 hr



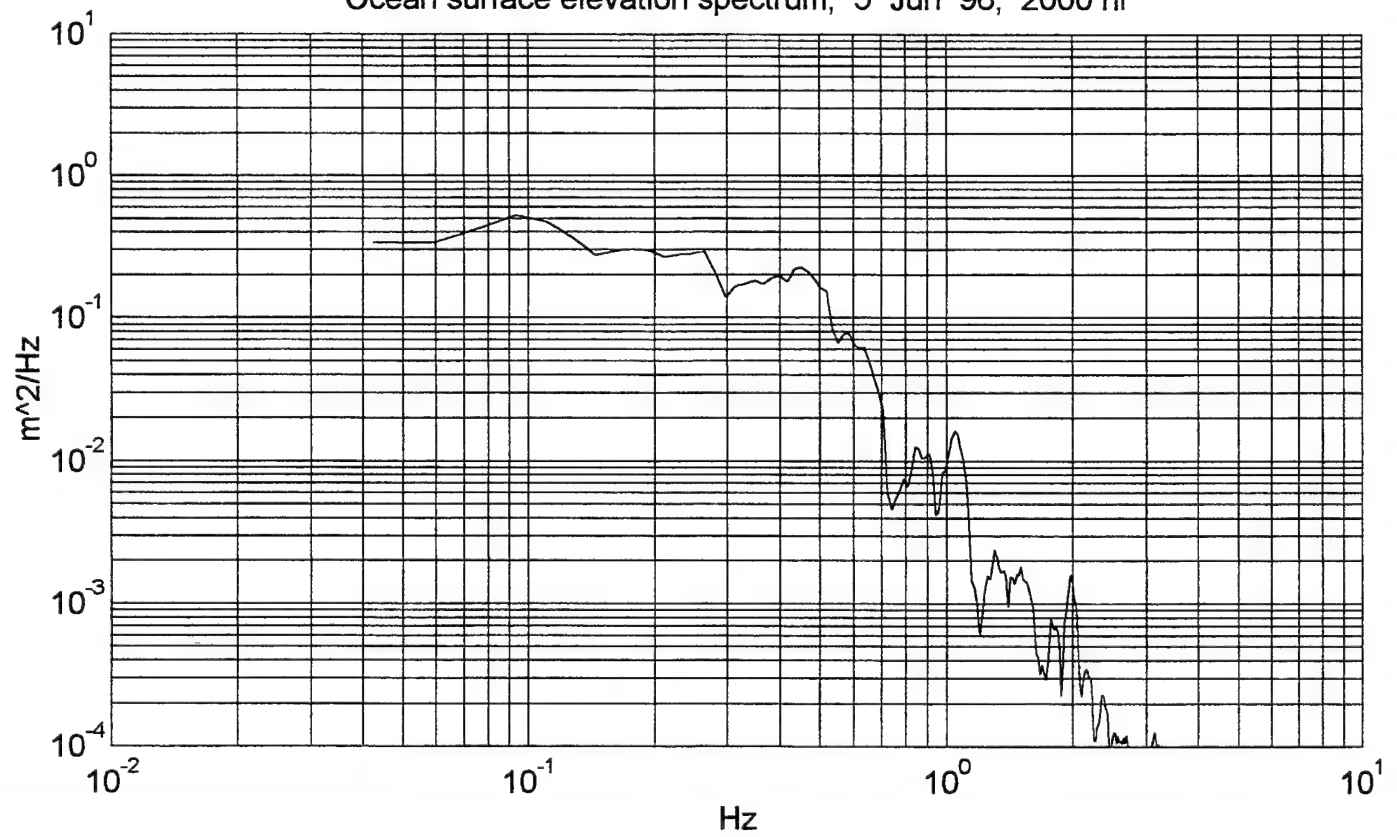
Ocean surface elevation spectrum, 5 Jun 96, 1945 hr



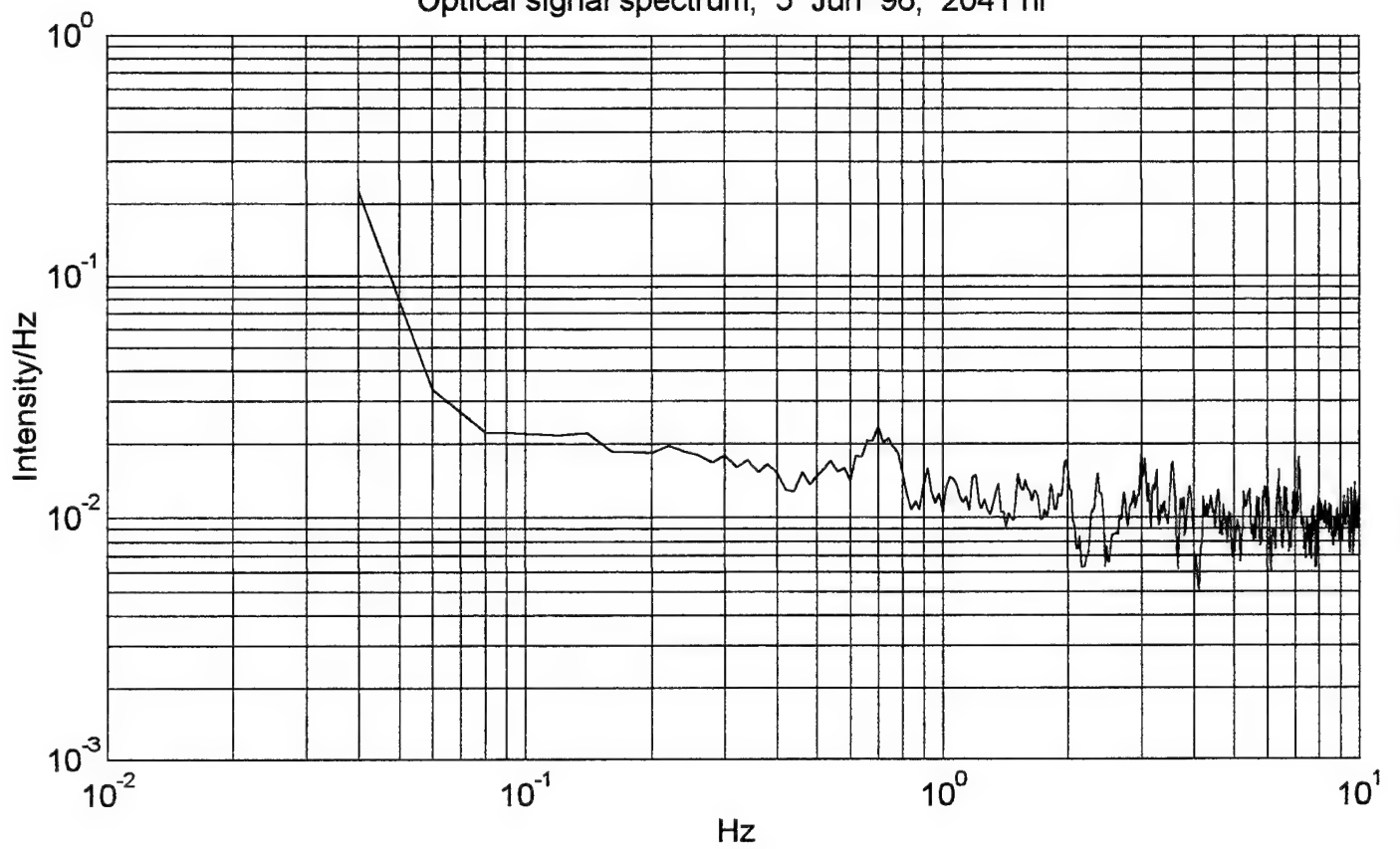
Optical signal spectrum, 5 Jun 96, 2000 hr



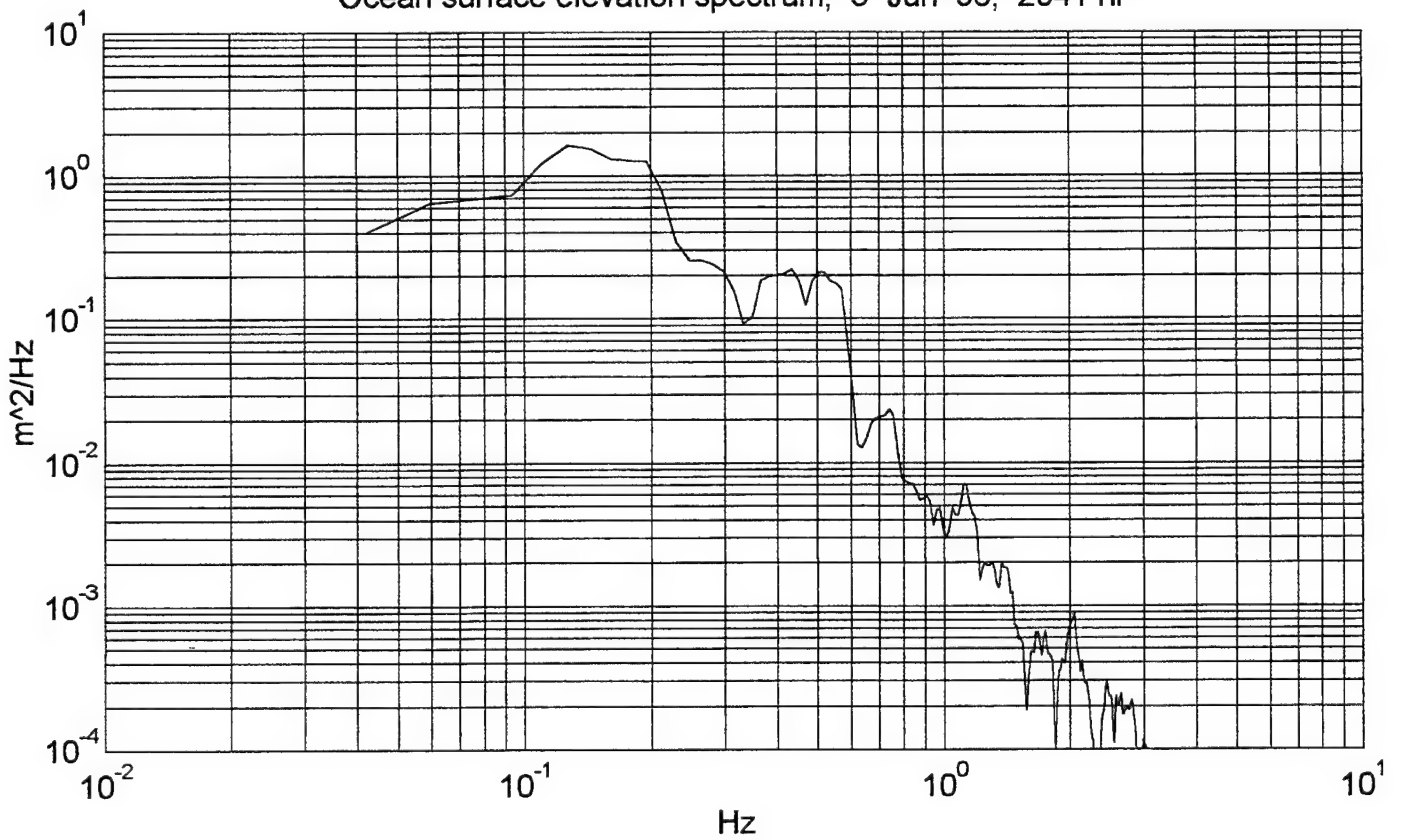
Ocean surface elevation spectrum, 5 Jun 96, 2000 hr



Optical signal spectrum, 5 Jun 96, 2041 hr

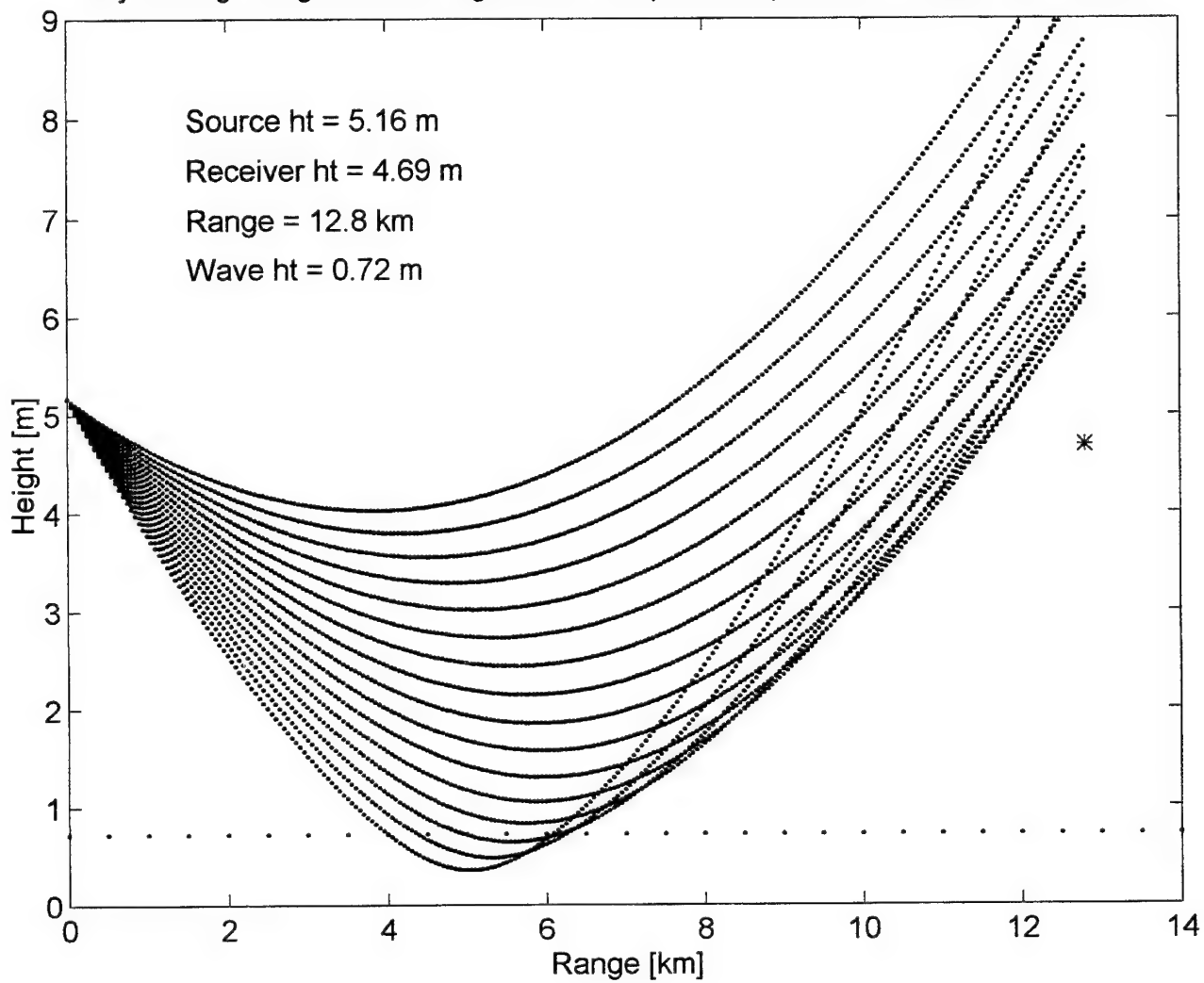


Ocean surface elevation spectrum, 5 Jun 96, 2041 hr

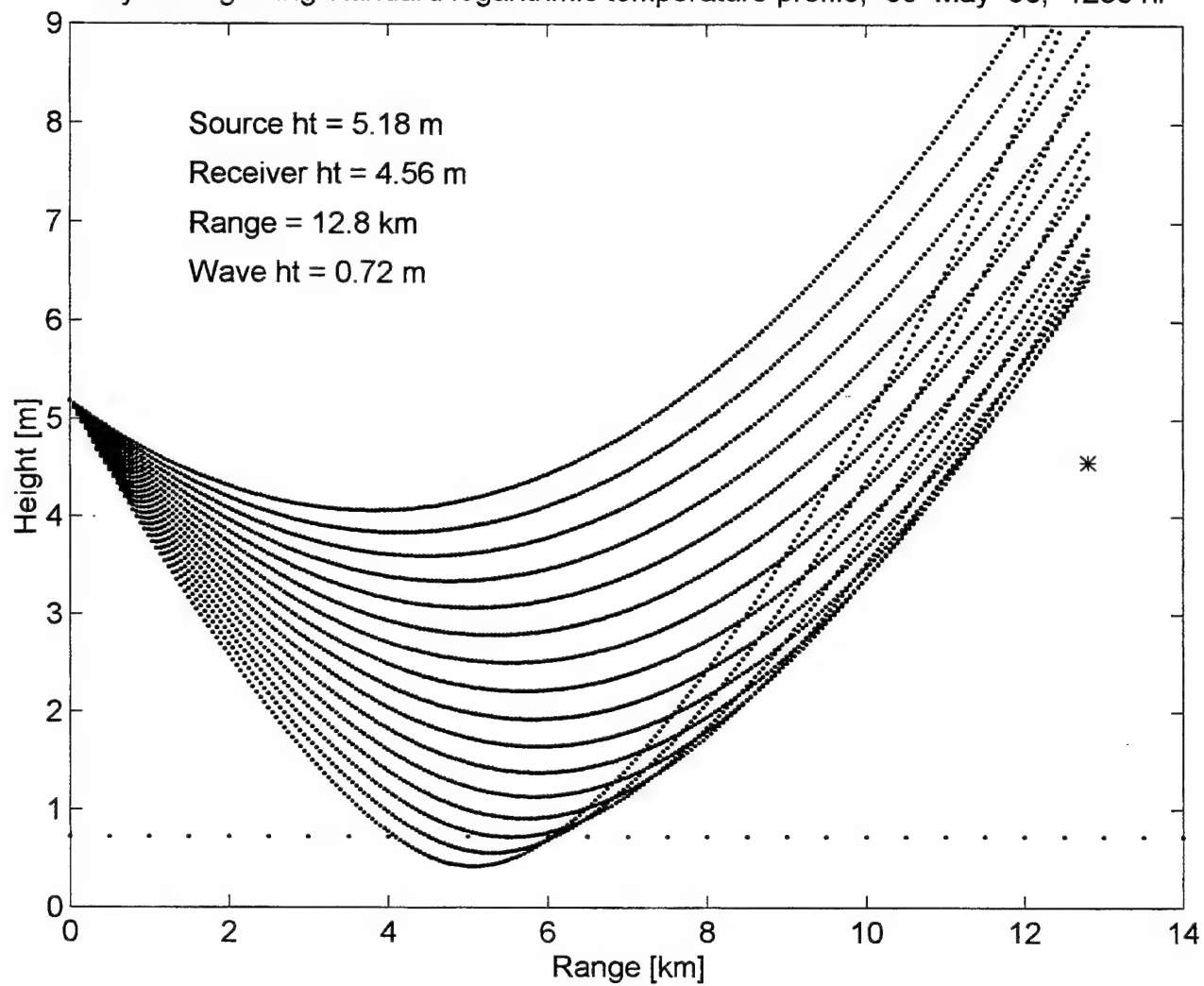


IV. RAY TRACING USING STANDARD LOGARITHMIC TEMPERATURE PROFILE

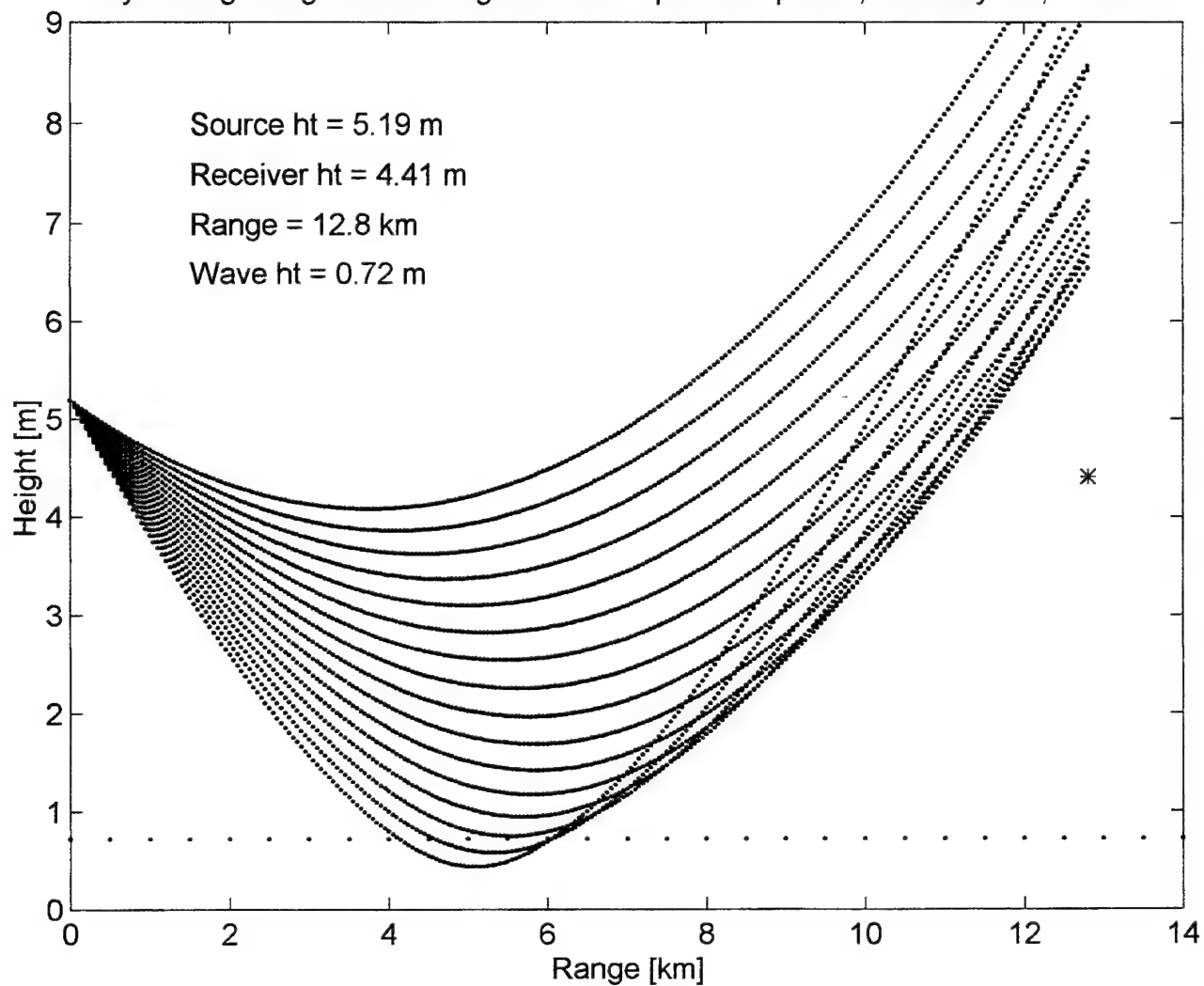
Ray tracing using standard logarithmic temperature profile, 30 May 96, 1225 hr



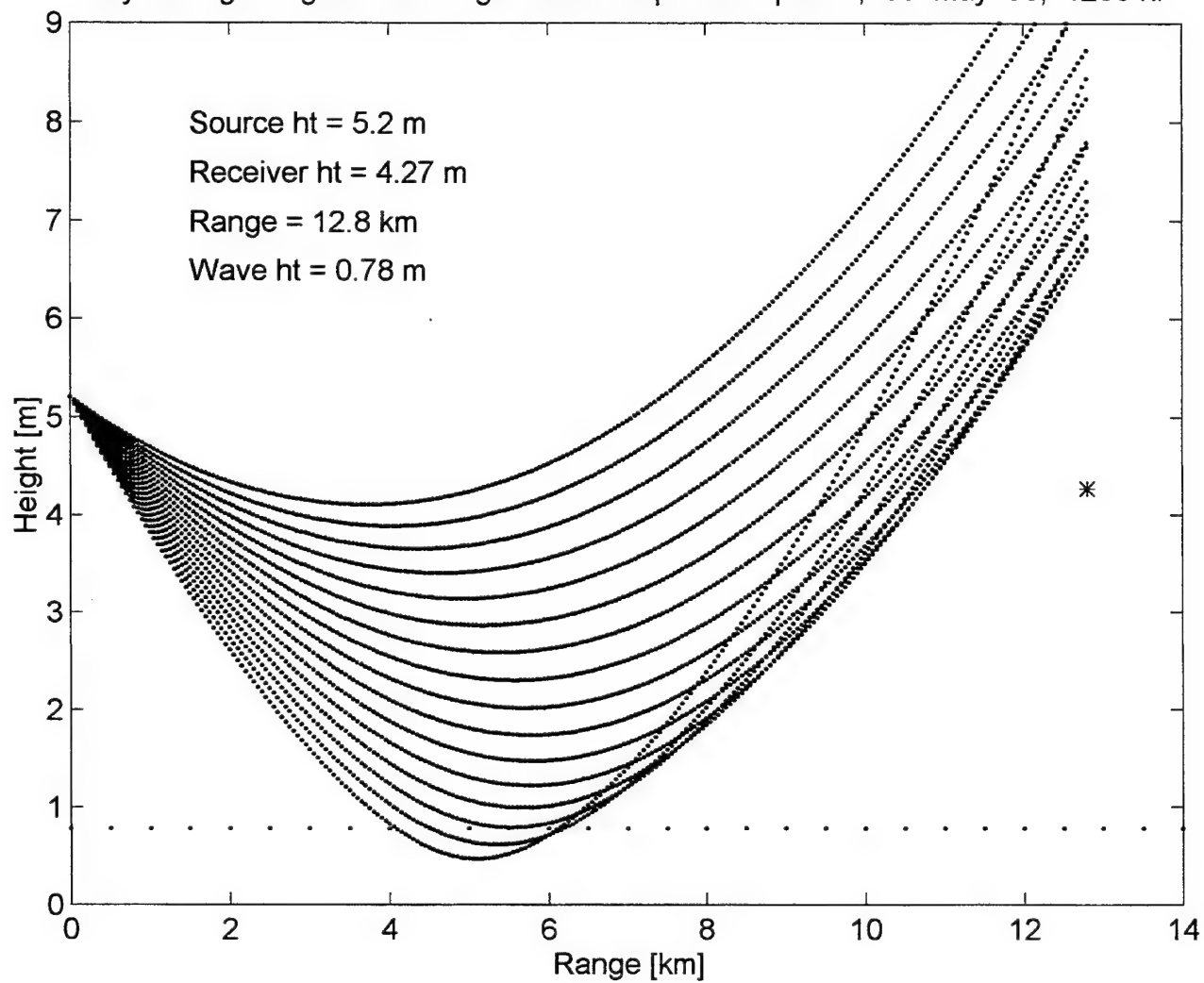
Ray tracing using standard logarithmic temperature profile, 30 May 96, 1230 hr



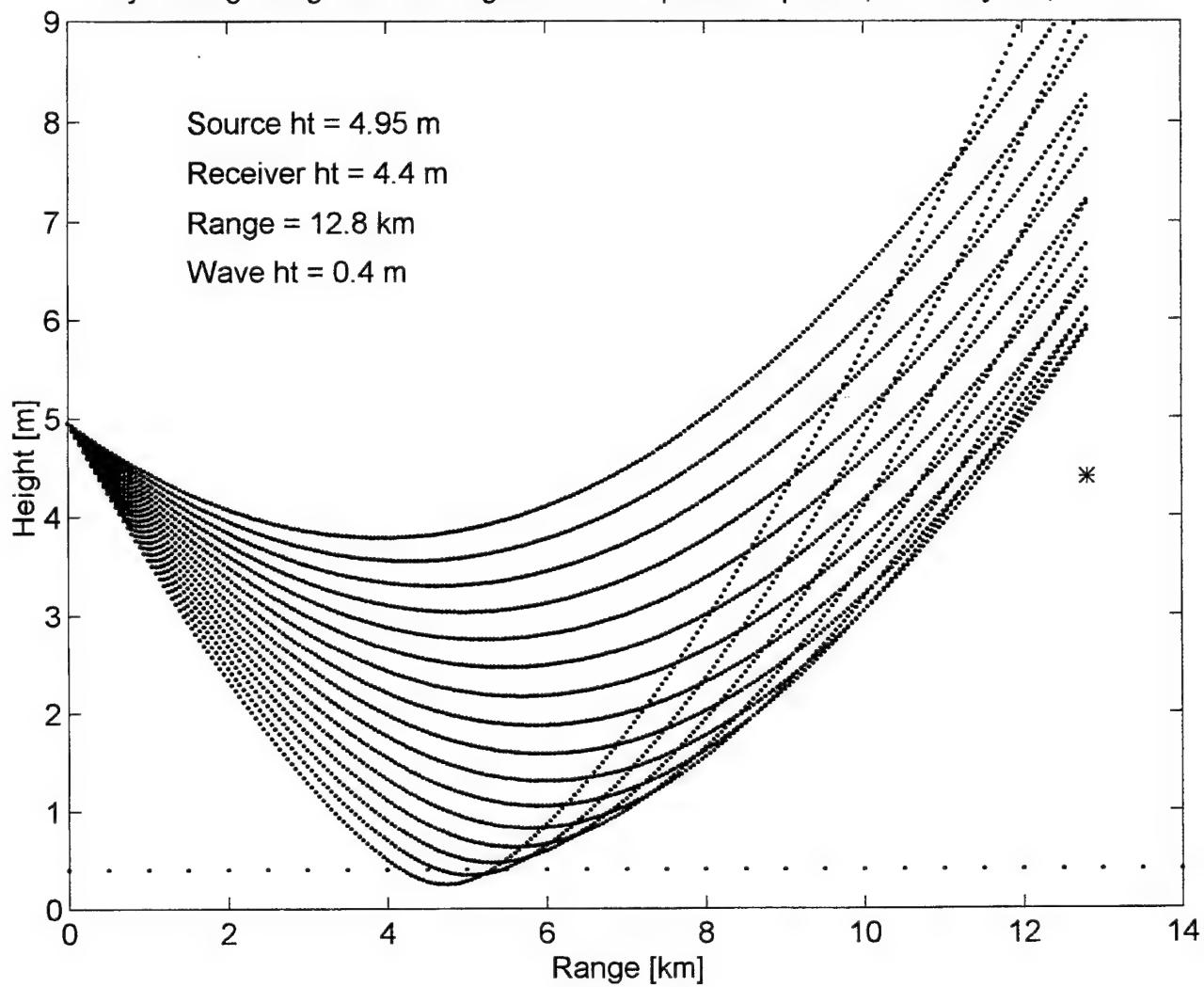
Ray tracing using standard logarithmic temperature profile, 30 May 96, 1233 hr



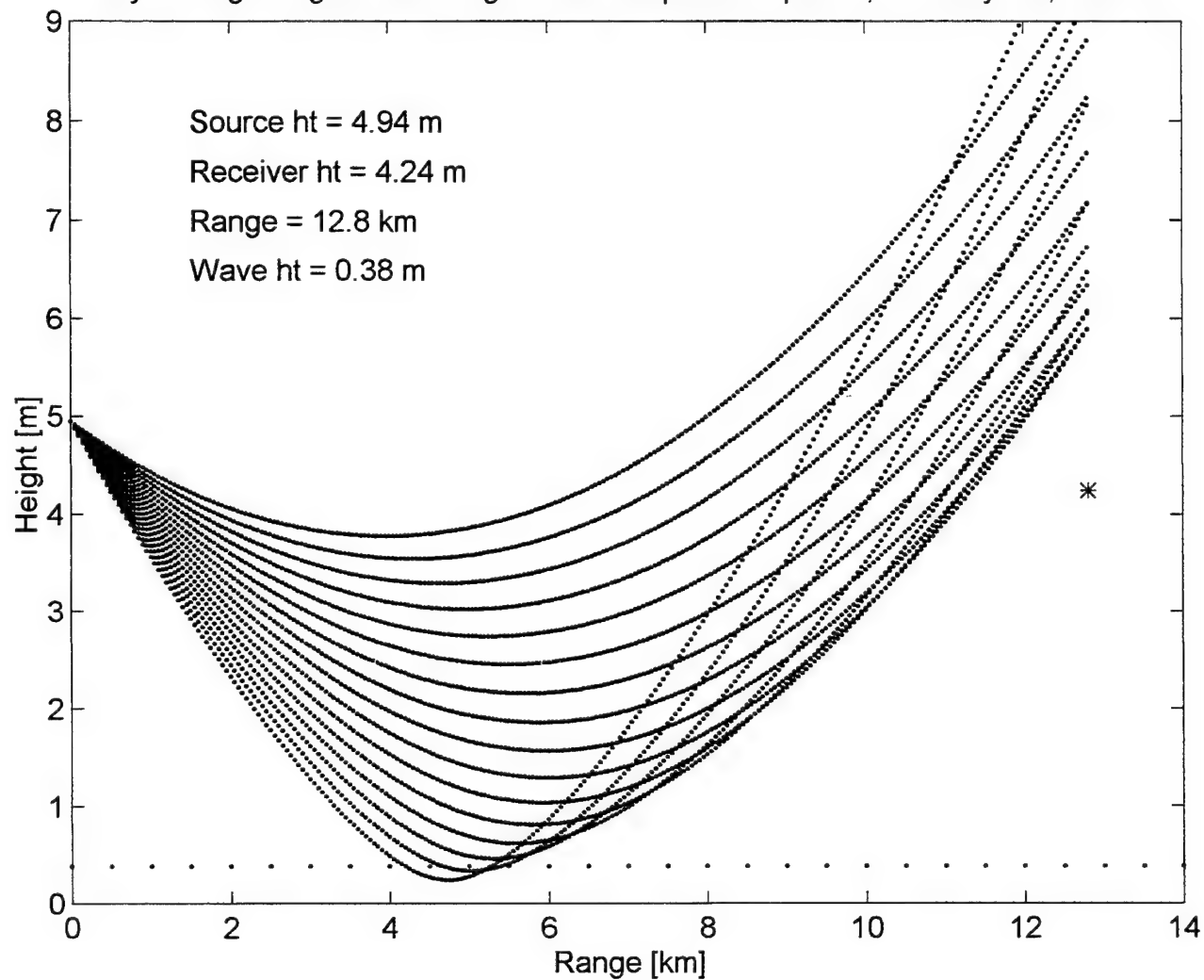
Ray tracing using standard logarithmic temperature profile, 30 May 96, 1236 hr



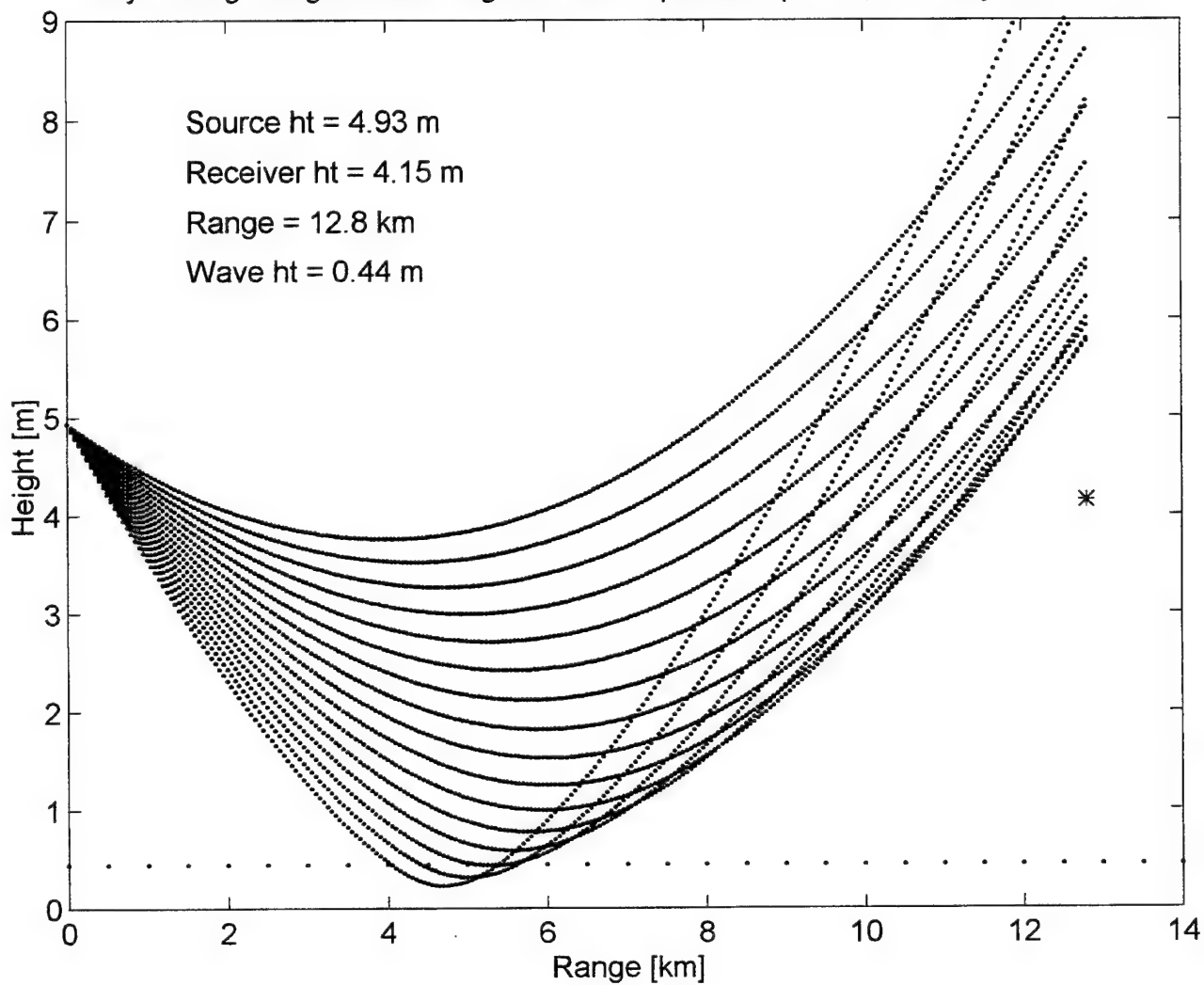
Ray tracing using standard logarithmic temperature profile, 31 May 96, 943 hr



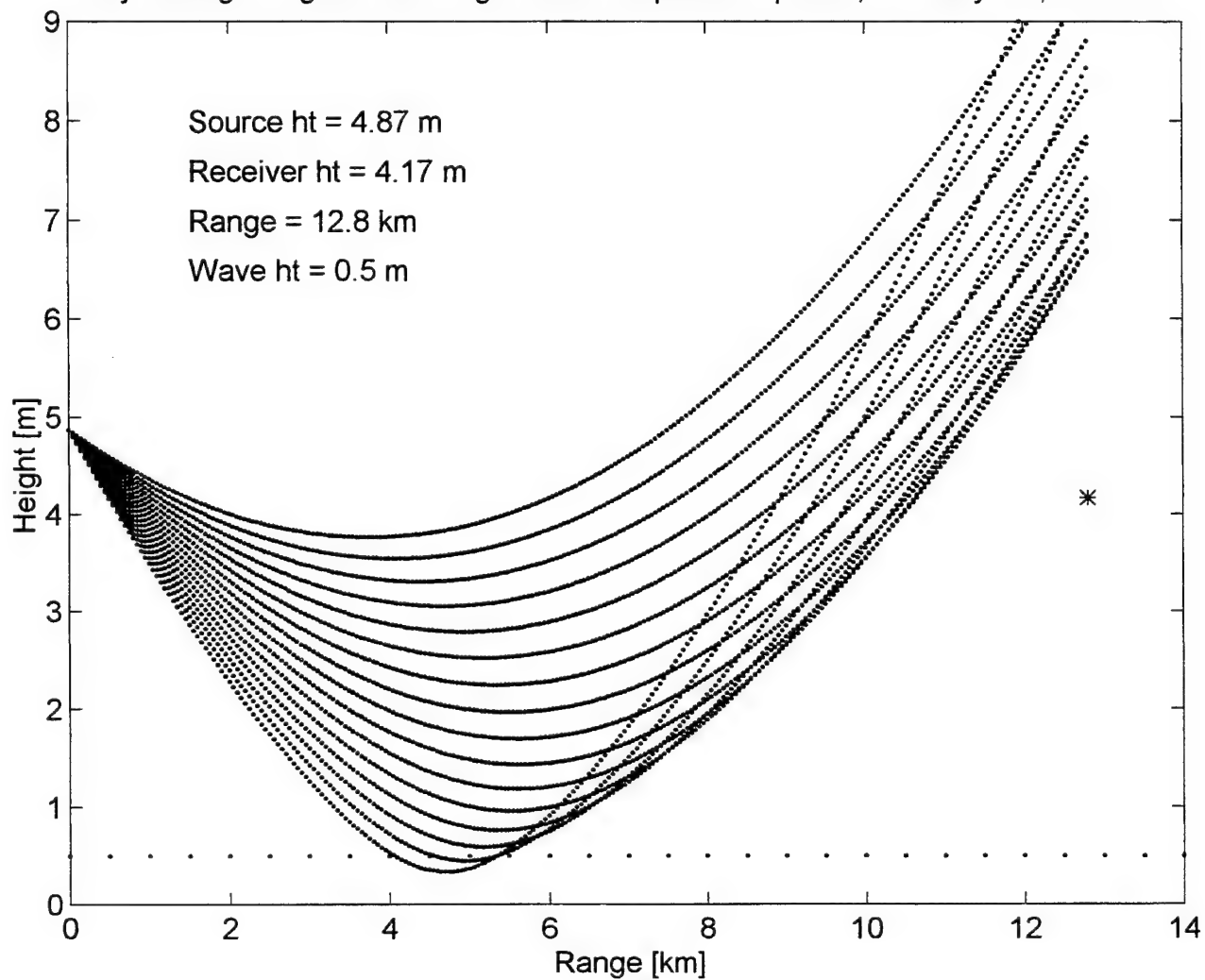
Ray tracing using standard logarithmic temperature profile, 31 May 96, 946 hr



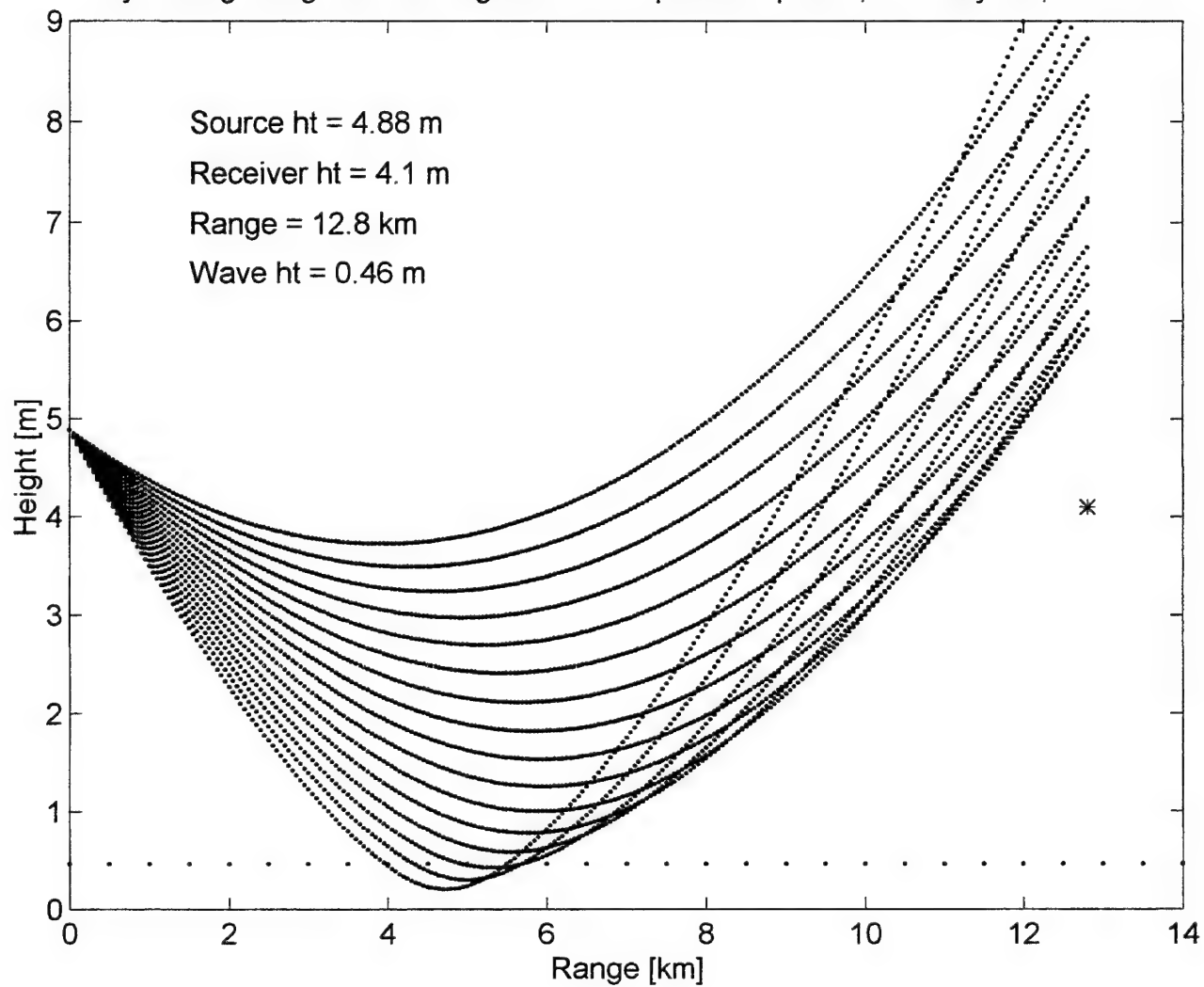
Ray tracing using standard logarithmic temperature profile, 31 May 96, 951 hr



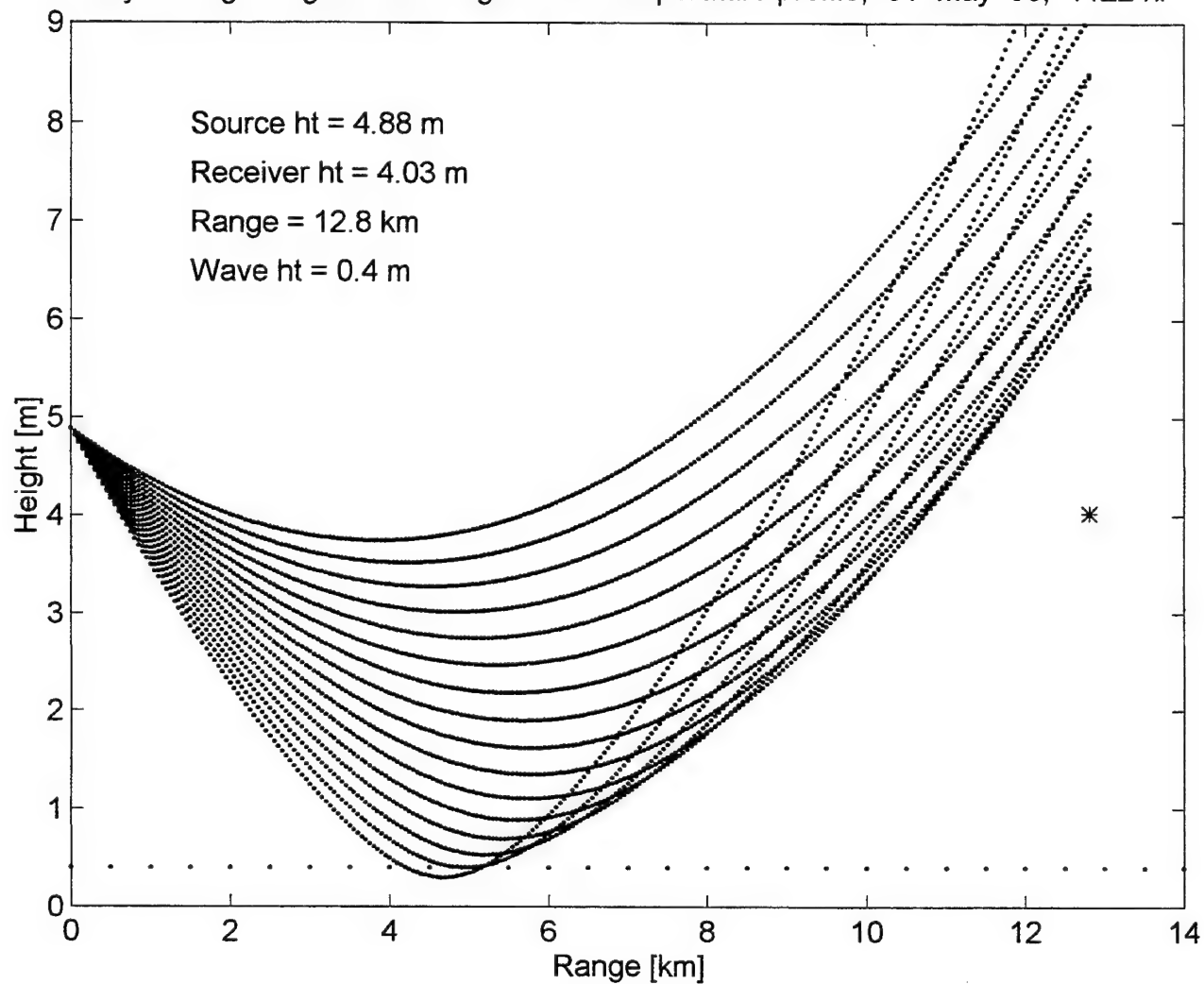
Ray tracing using standard logarithmic temperature profile, 31 May 96, 1115 hr



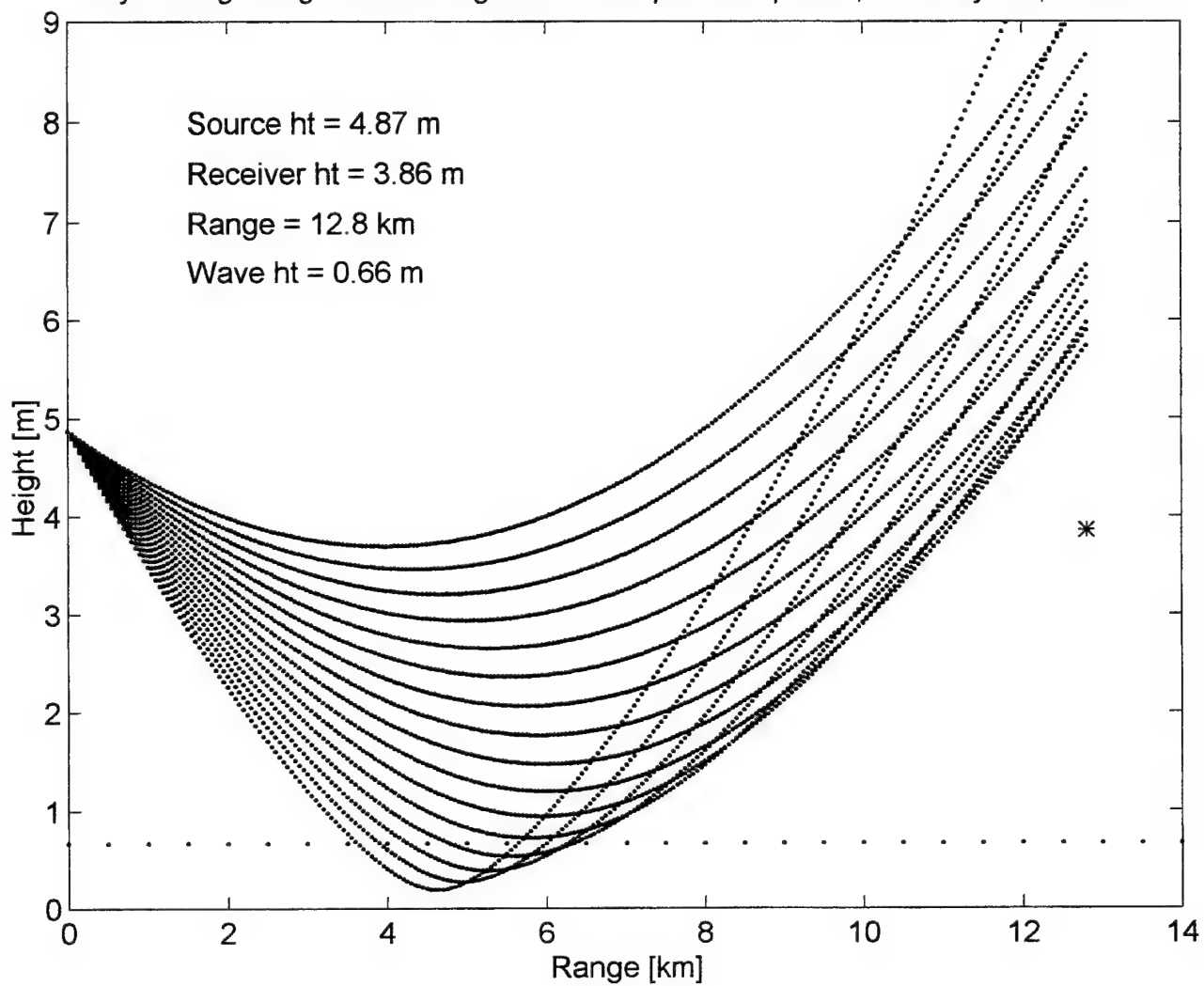
Ray tracing using standard logarithmic temperature profile, 31 May 96, 1120 hr



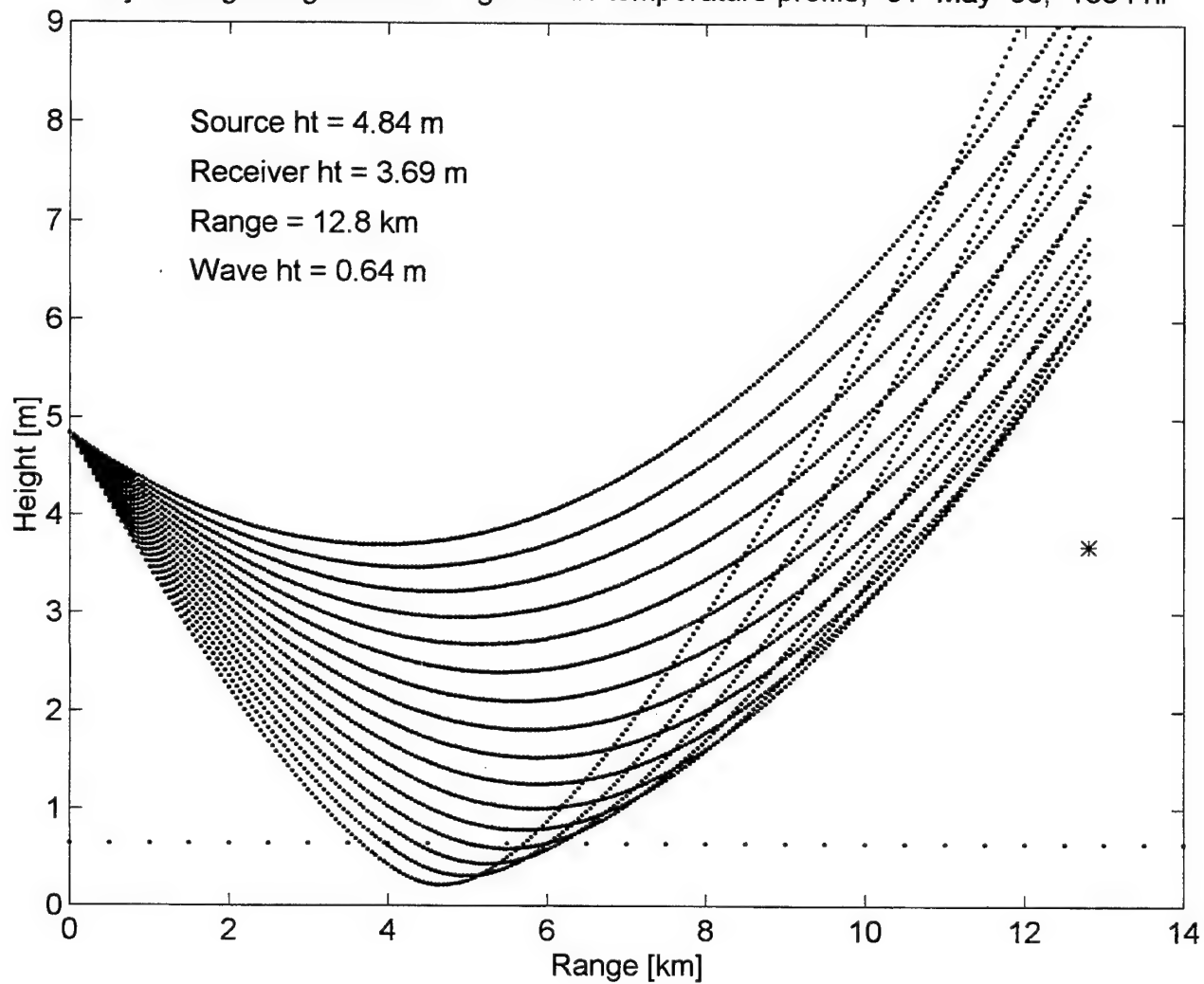
Ray tracing using standard logarithmic temperature profile, 31 May 96, 1122 hr



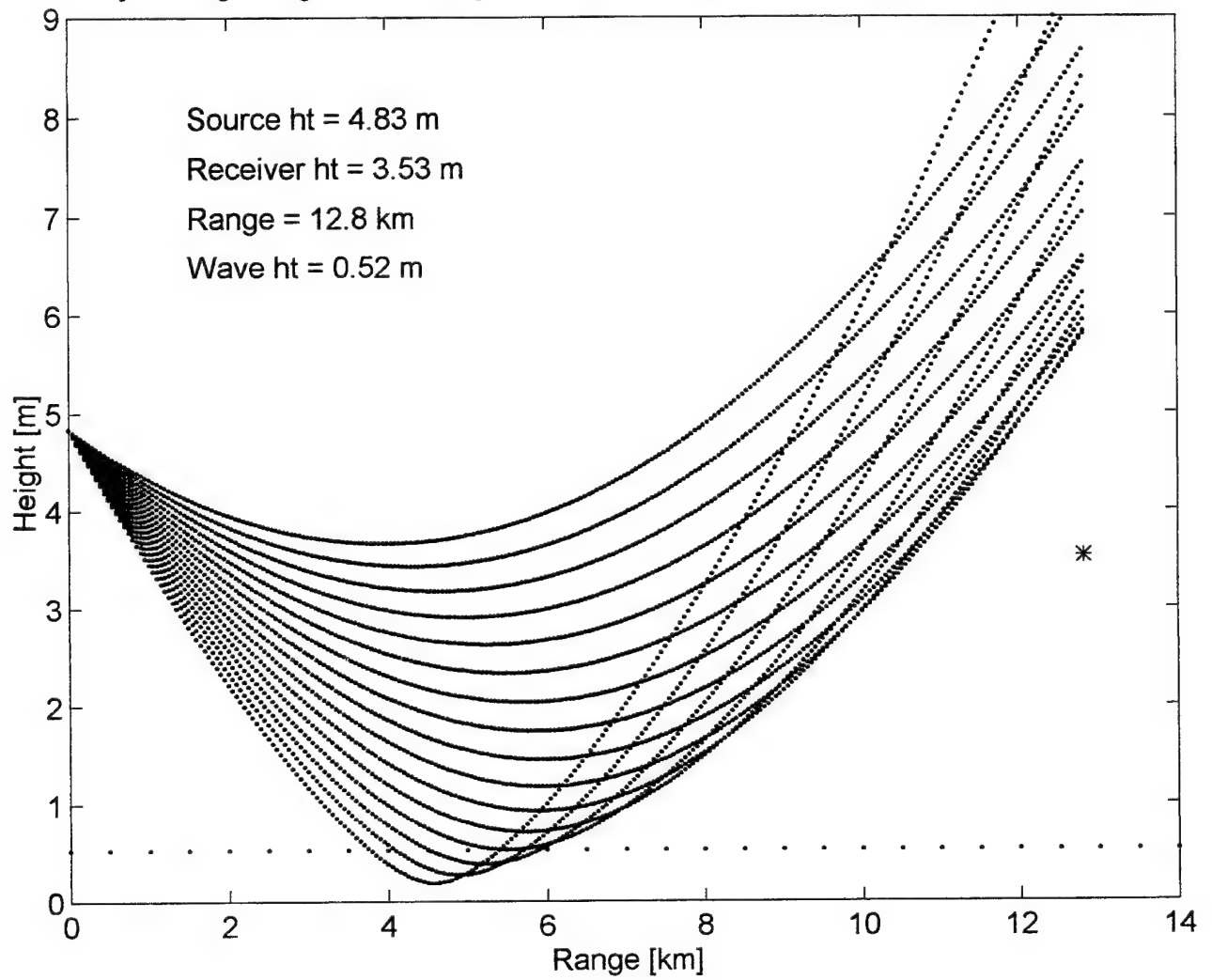
Ray tracing using standard logarithmic temperature profile, 31 May 96, 1830 hr



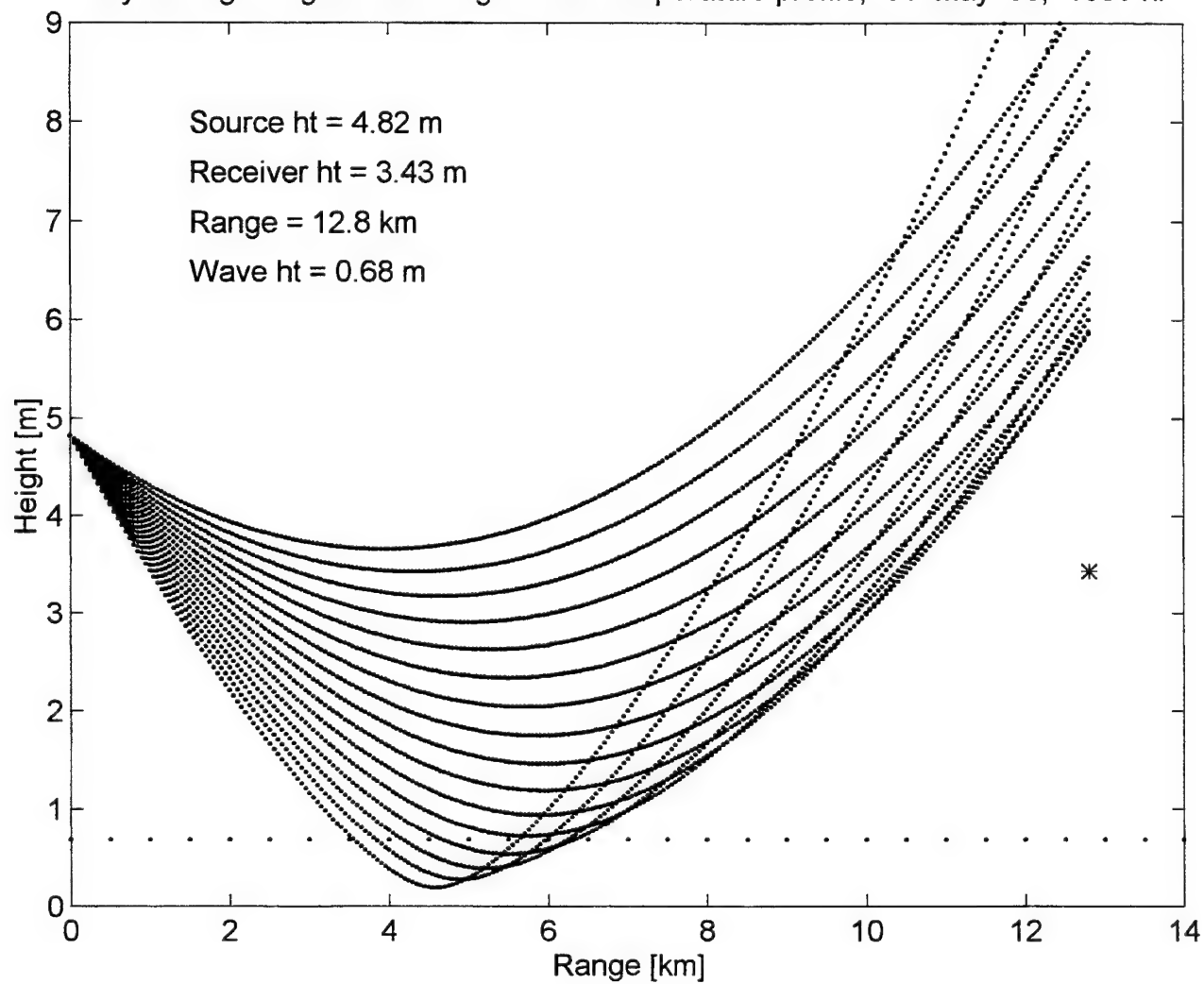
Ray tracing using standard logarithmic temperature profile, 31 May 96, 1834 hr

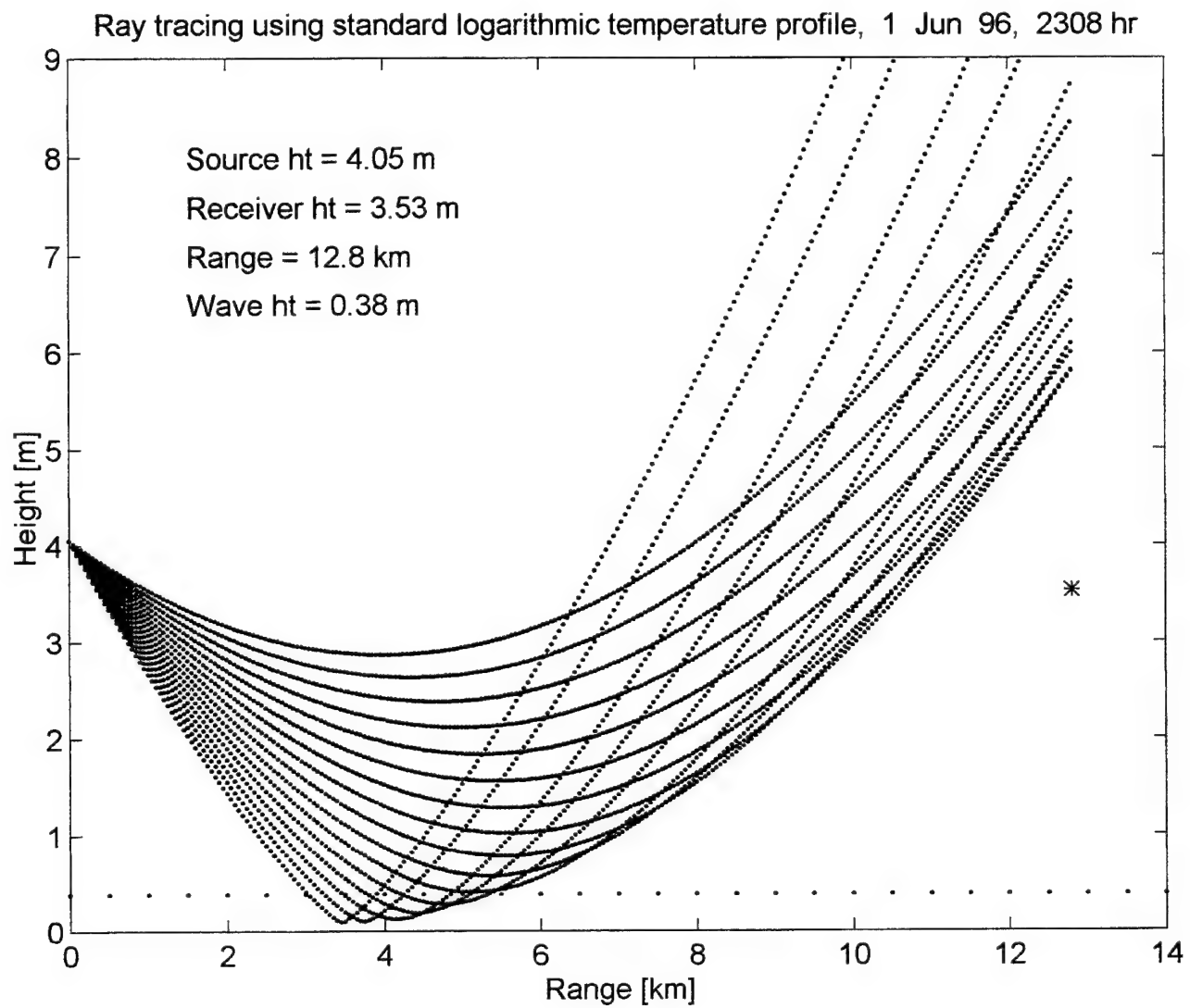


Ray tracing using standard logarithmic temperature profile, 31 May 96, 1836 hr

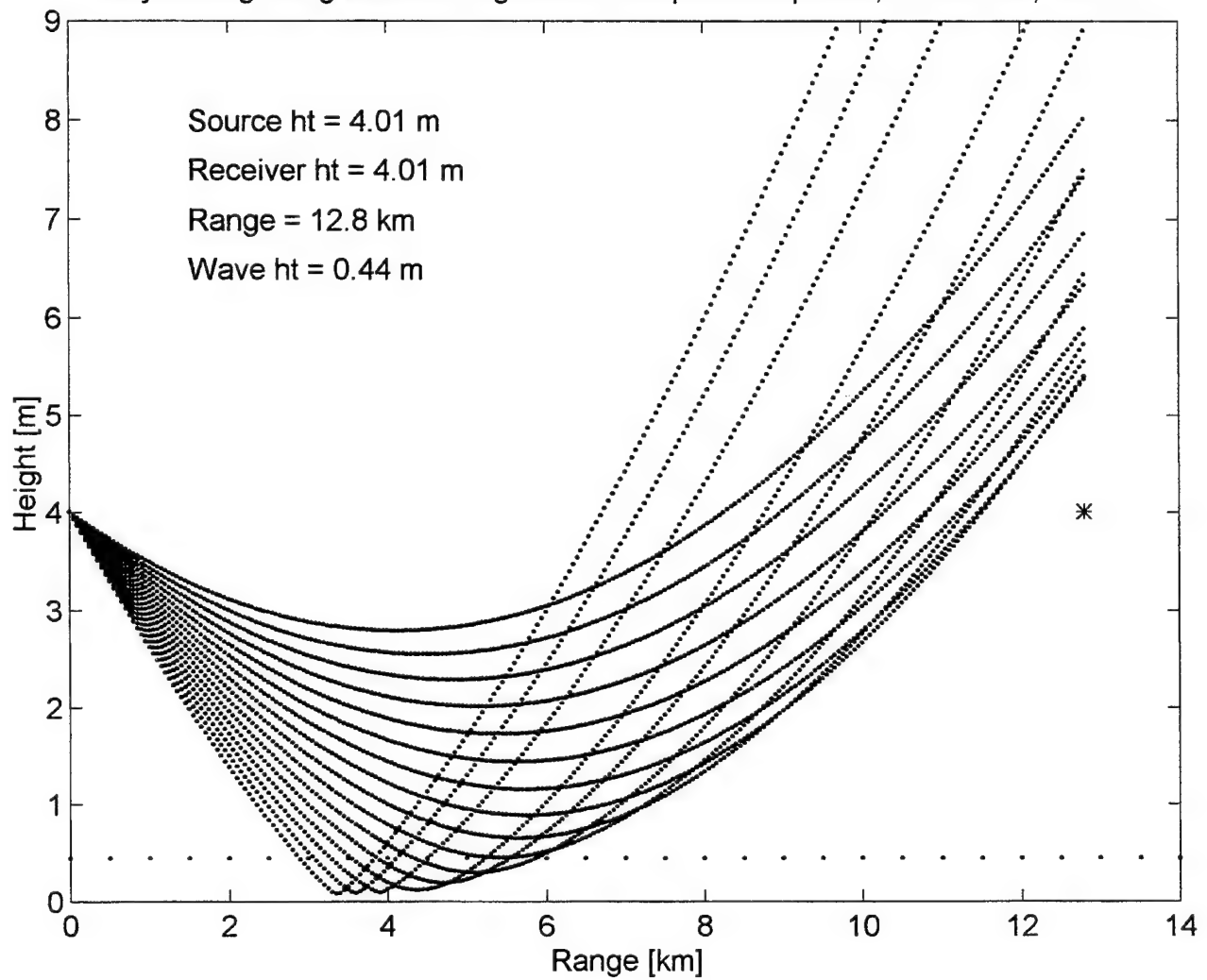


Ray tracing using standard logarithmic temperature profile, 31 May 96, 1839 hr

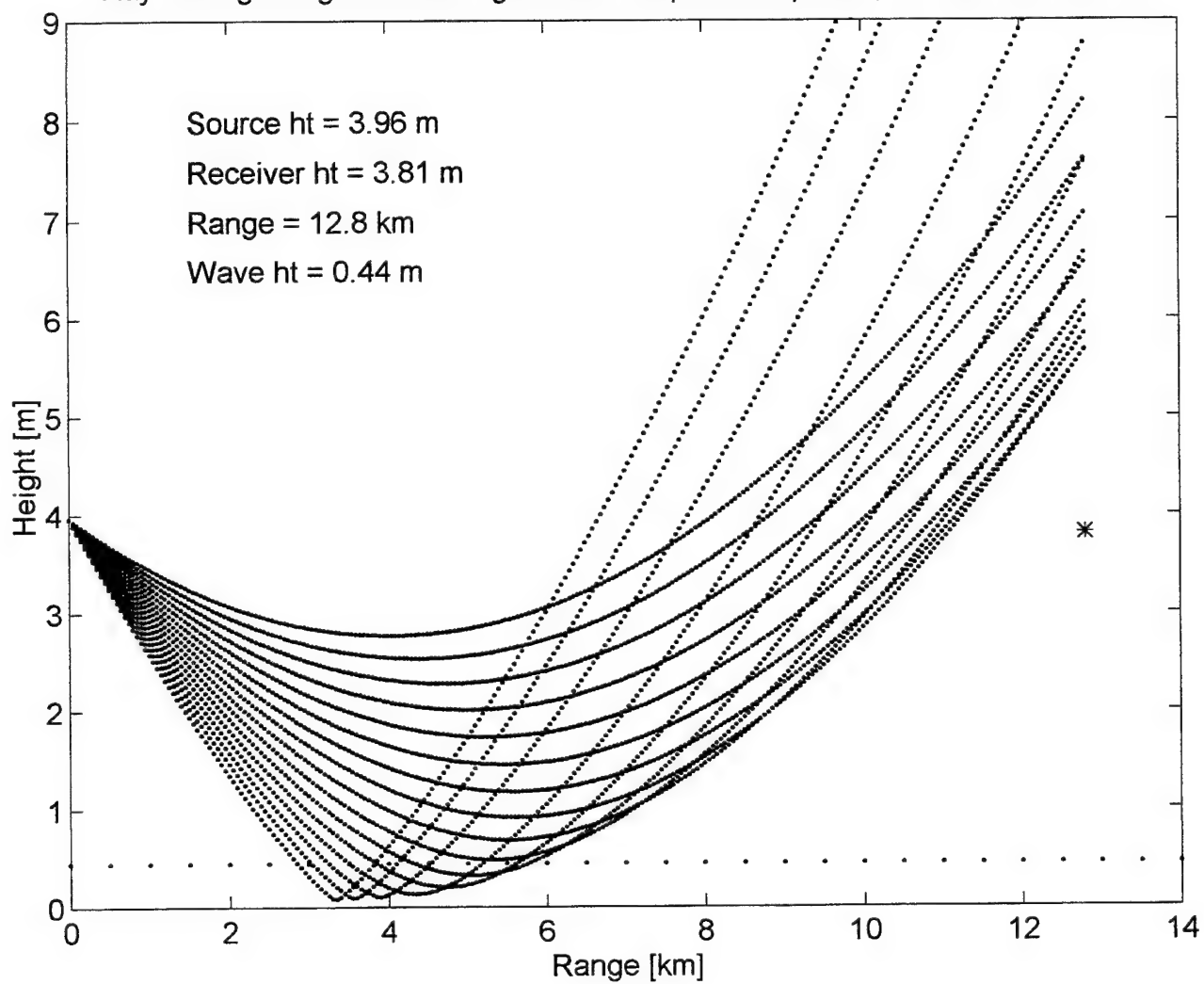




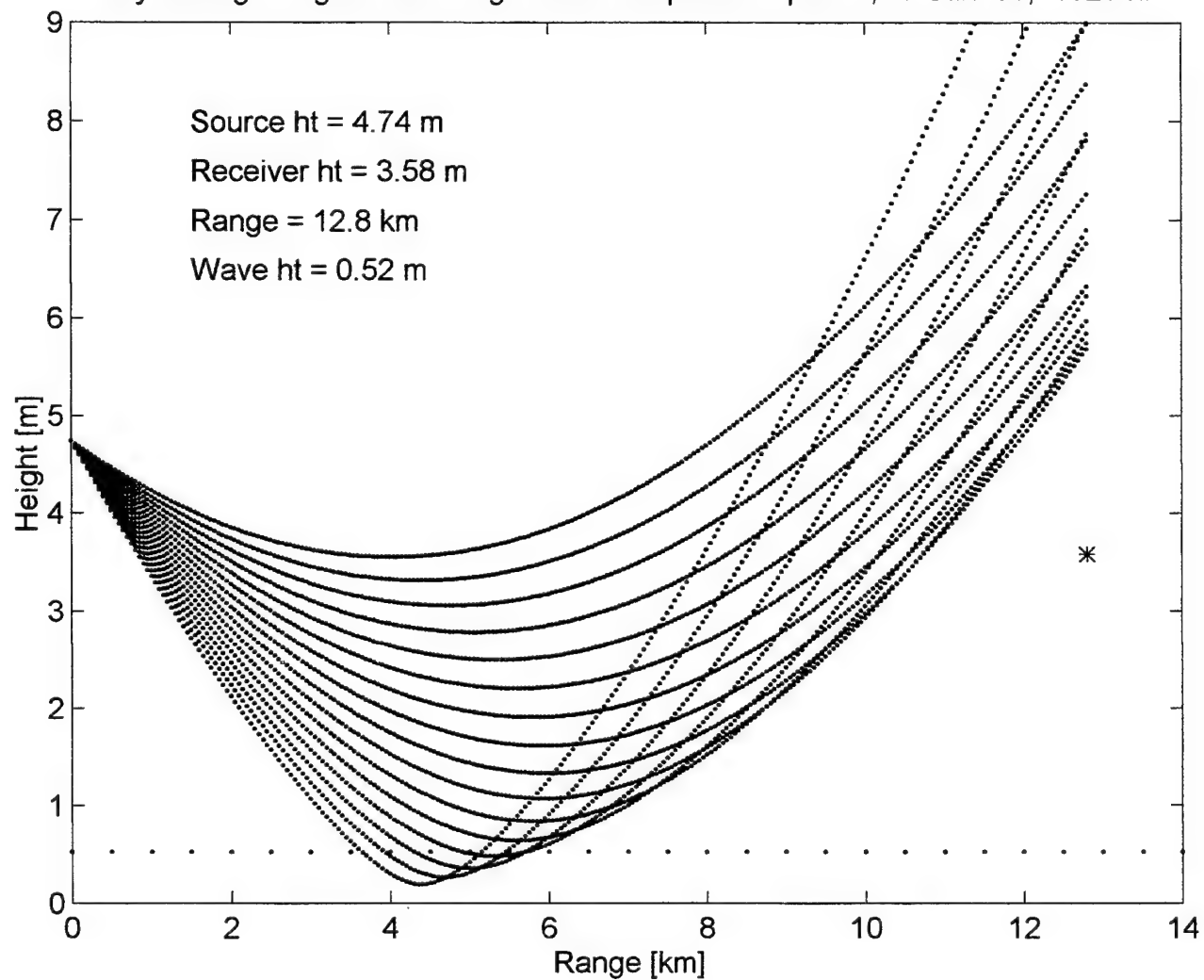
Ray tracing using standard logarithmic temperature profile, 3 Jun 96, 930 hr



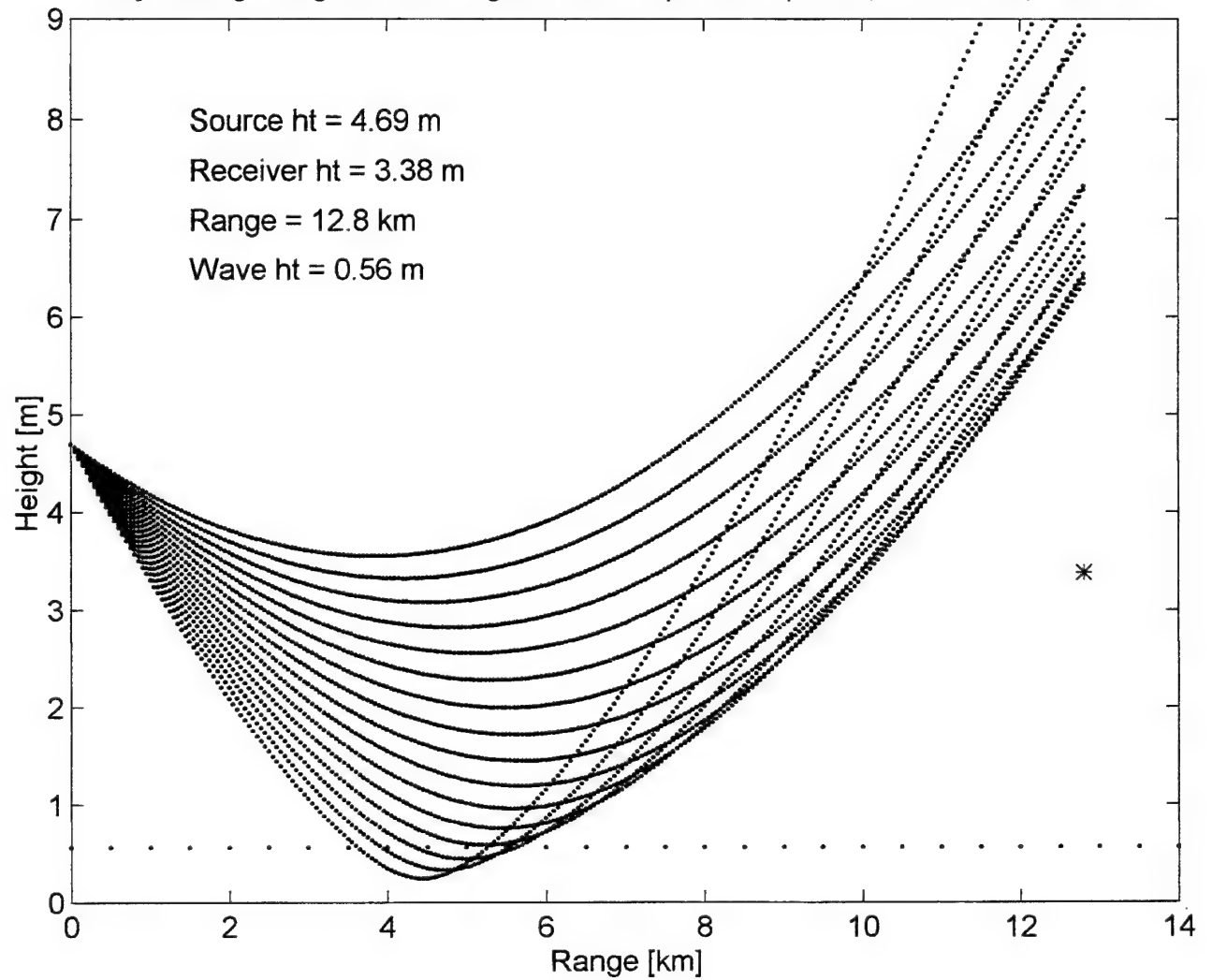
Ray tracing using standard logarithmic temperature profile, 3 Jun 96, 937 hr



Ray tracing using standard logarithmic temperature profile, 4 Jun 96, 1325 hr

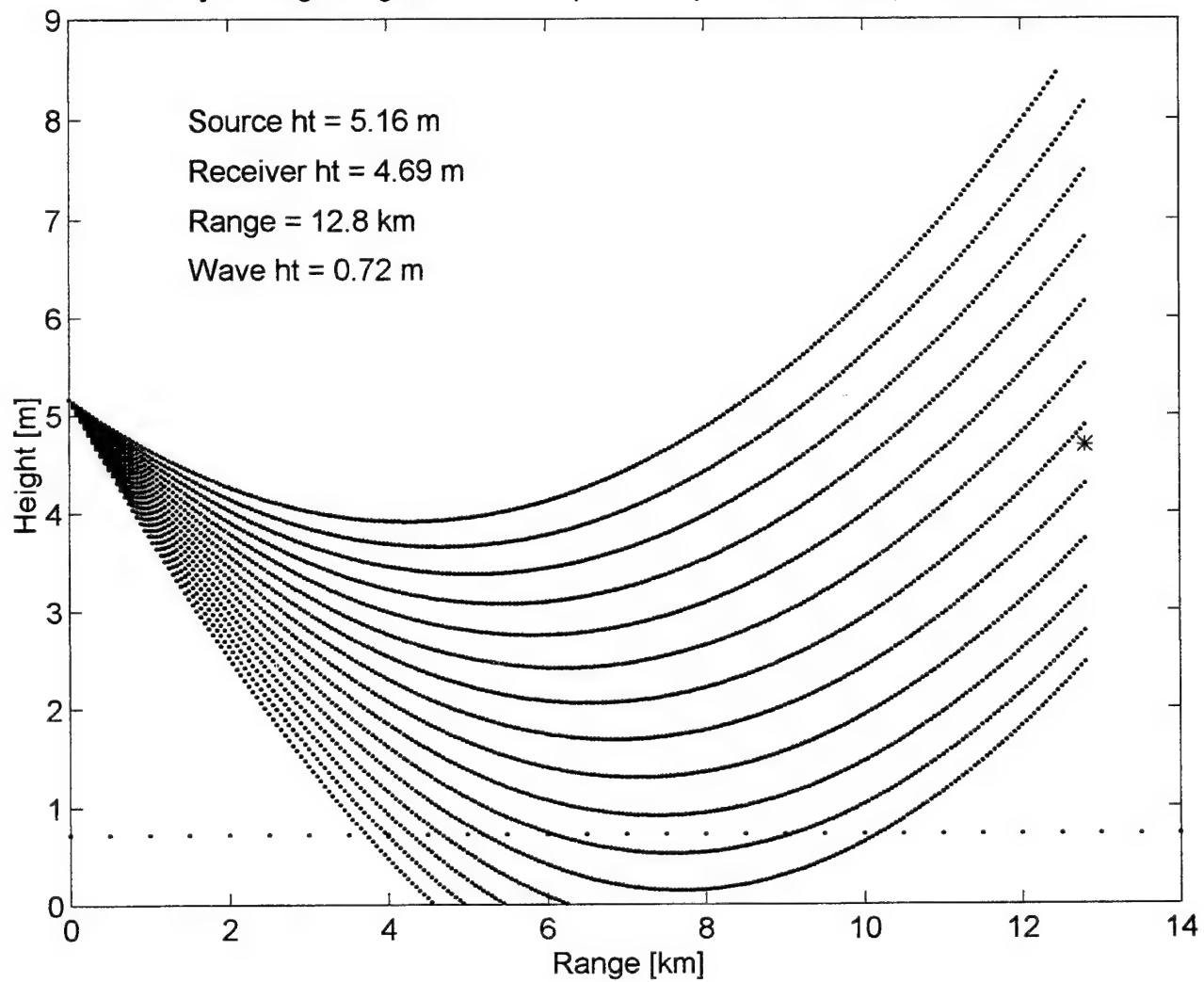


Ray tracing using standard logarithmic temperature profile, 4 Jun 96, 1426 hr

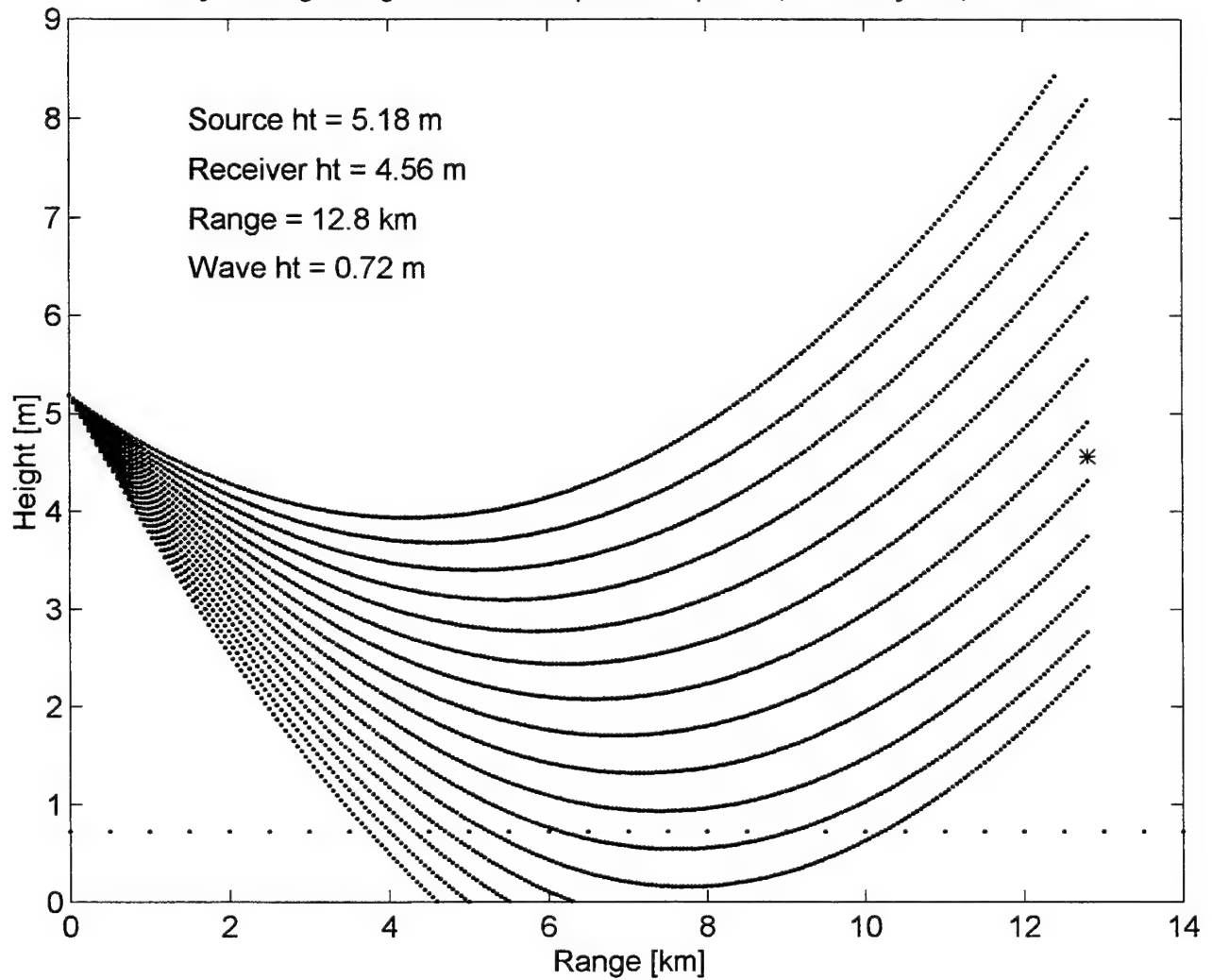


V. RAY TRACING USING MODIFIED TEMPERATURE PROFILE

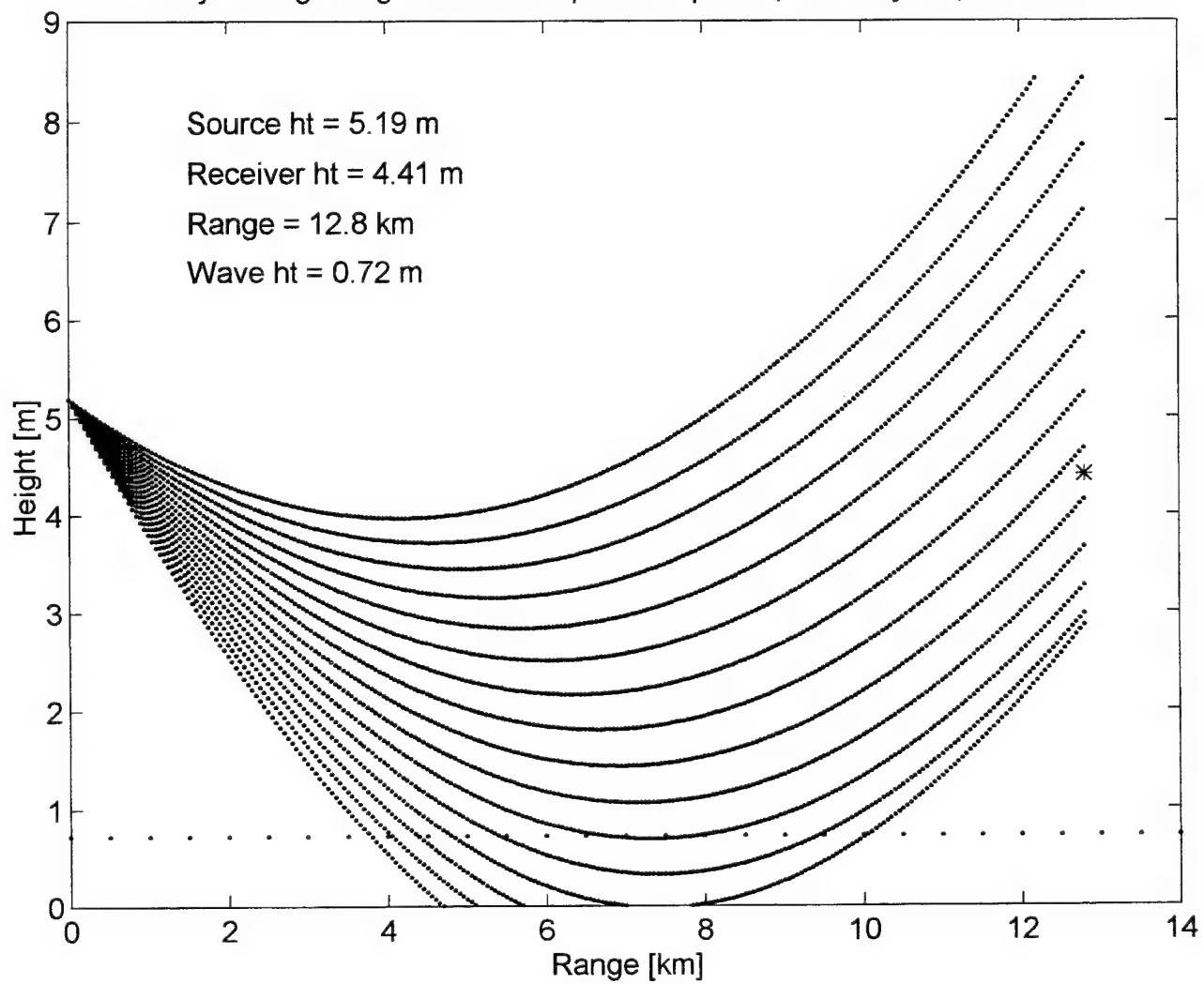
Ray tracing using modified temperature profile, 30 May 96, 1225 hr



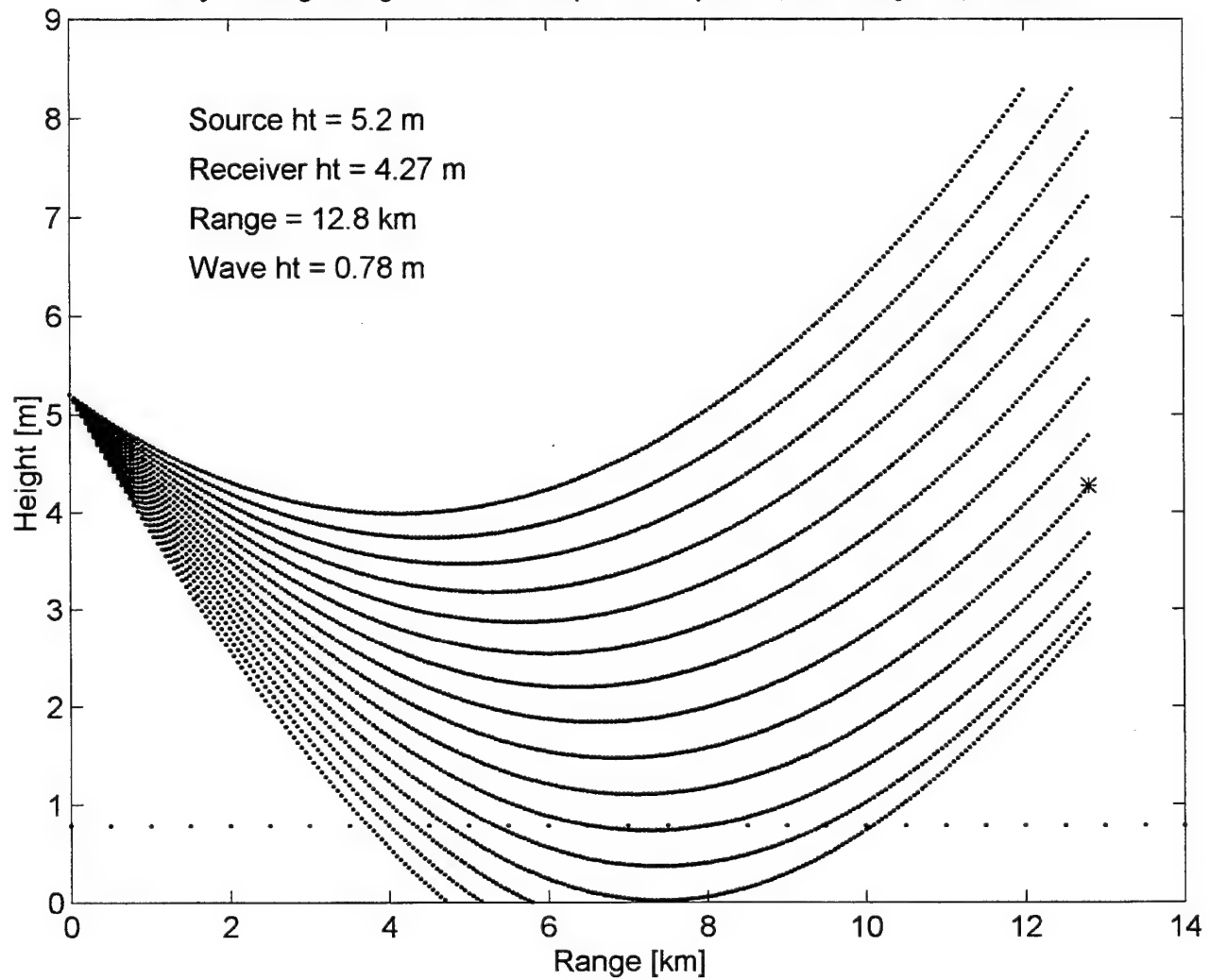
Ray tracing using modified temperature profile, 30 May 96, 1230 hr



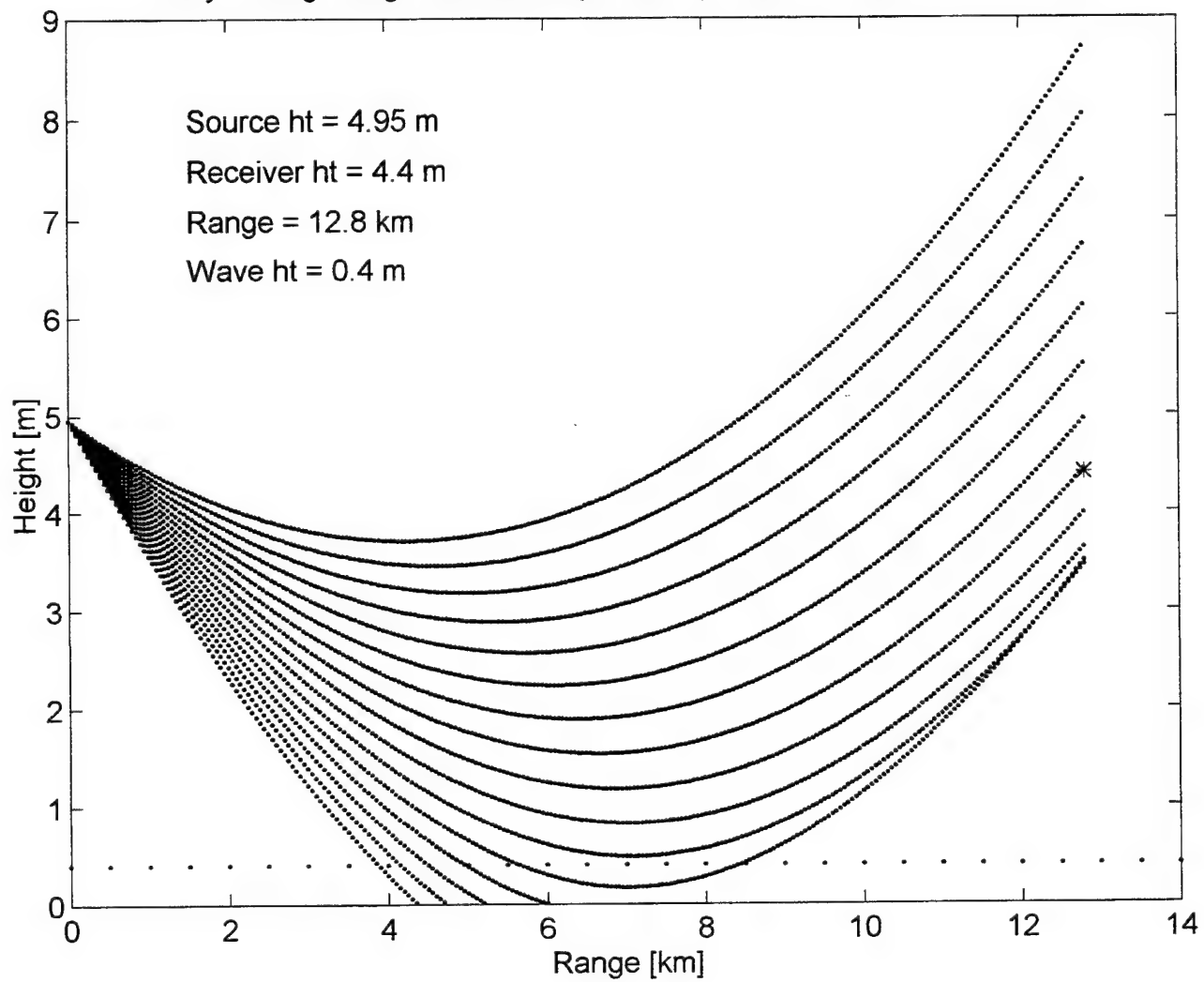
Ray tracing using modified temperature profile, 30 May 96, 1233 hr



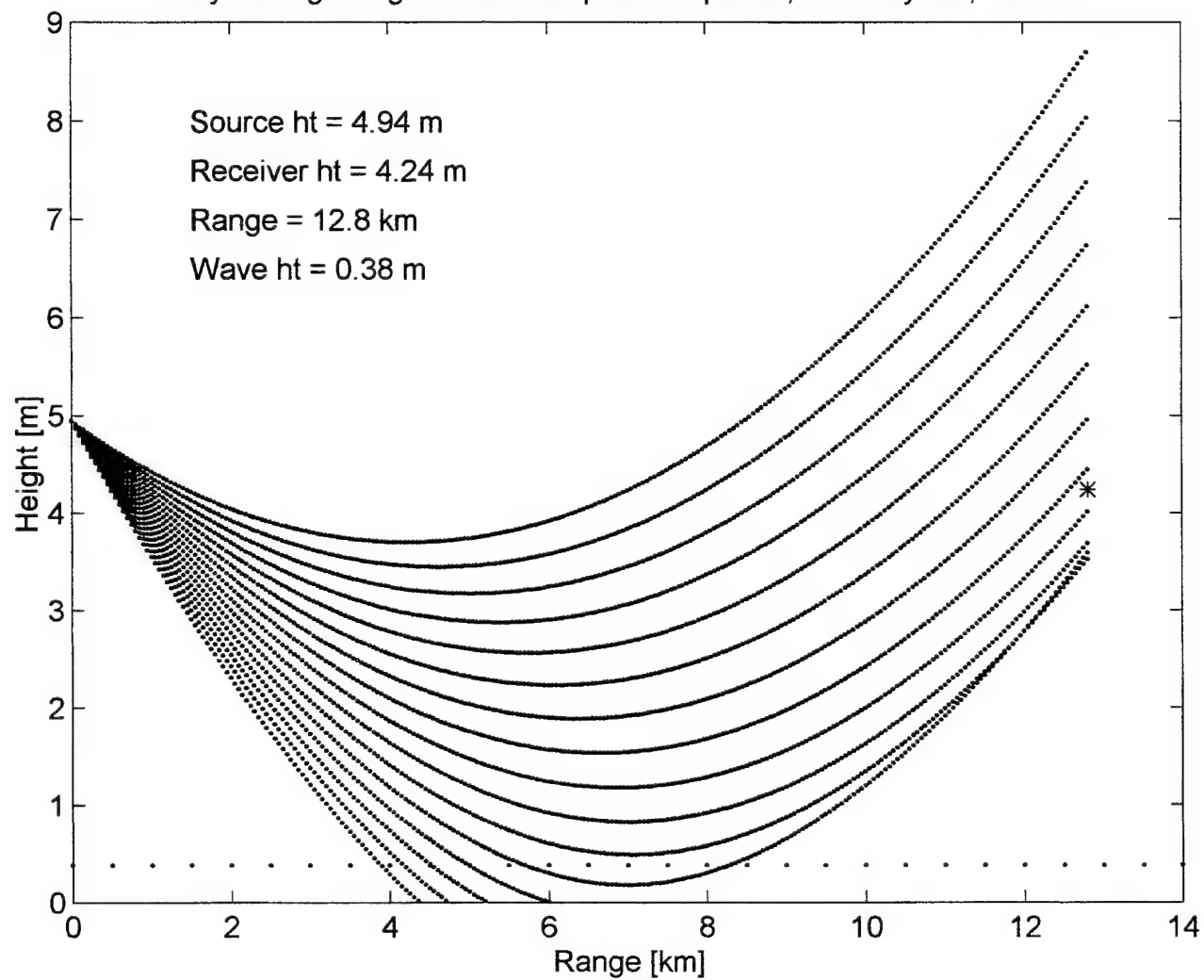
Ray tracing using modified temperature profile, 30 May 96, 1236 hr



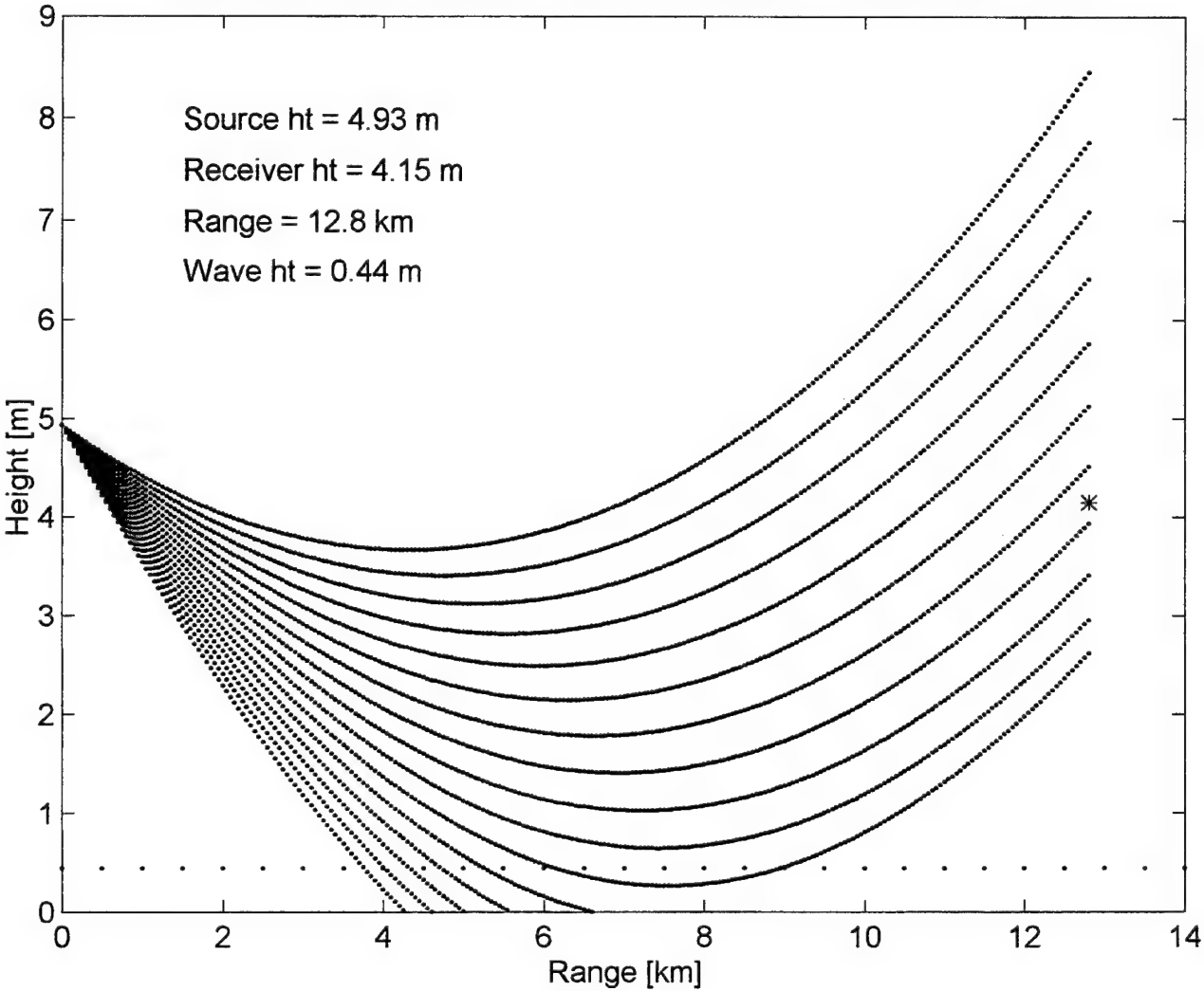
Ray tracing using modified temperature profile, 31 May 96, 943 hr



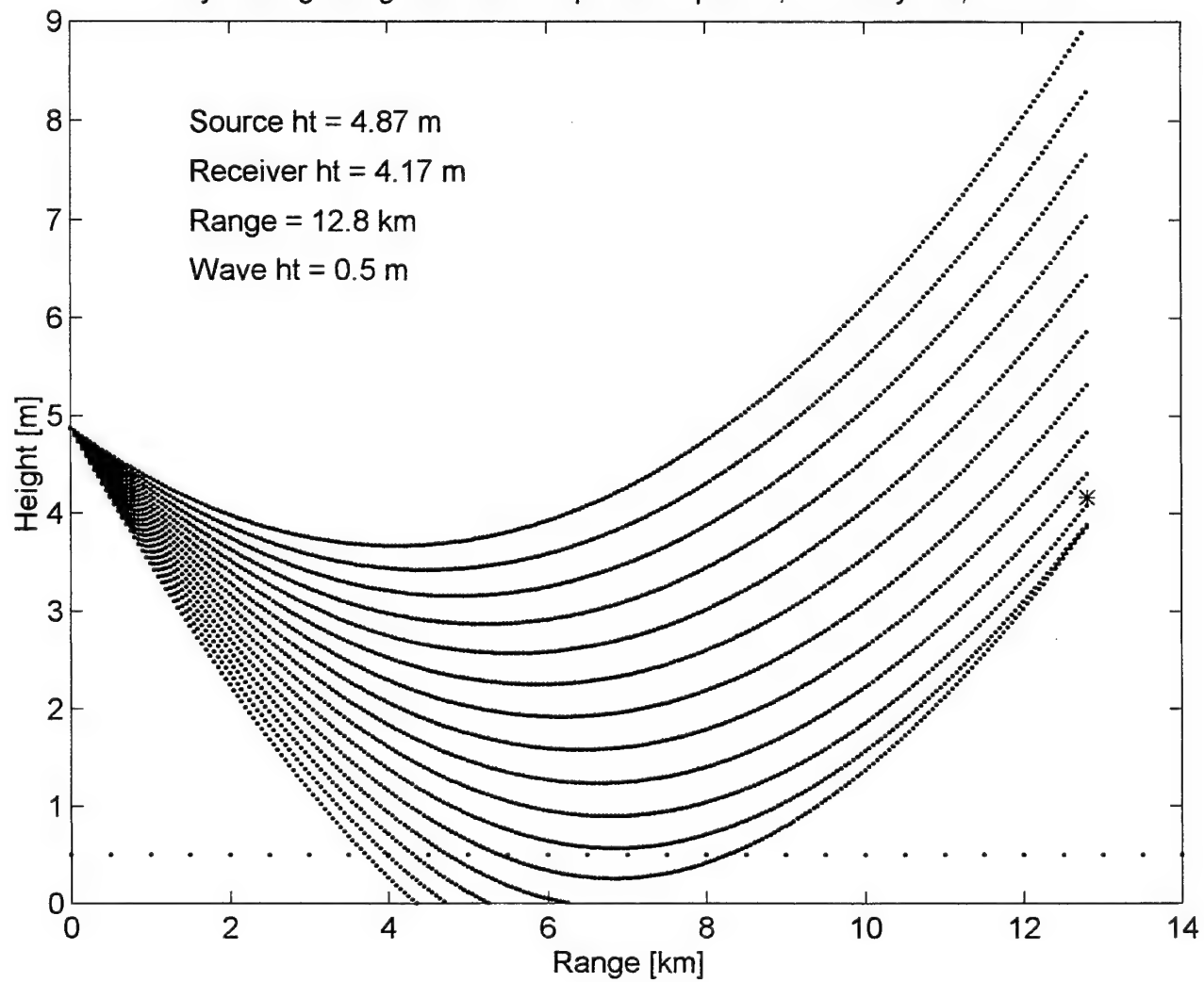
Ray tracing using modified temperature profile, 31 May 96, 946 hr



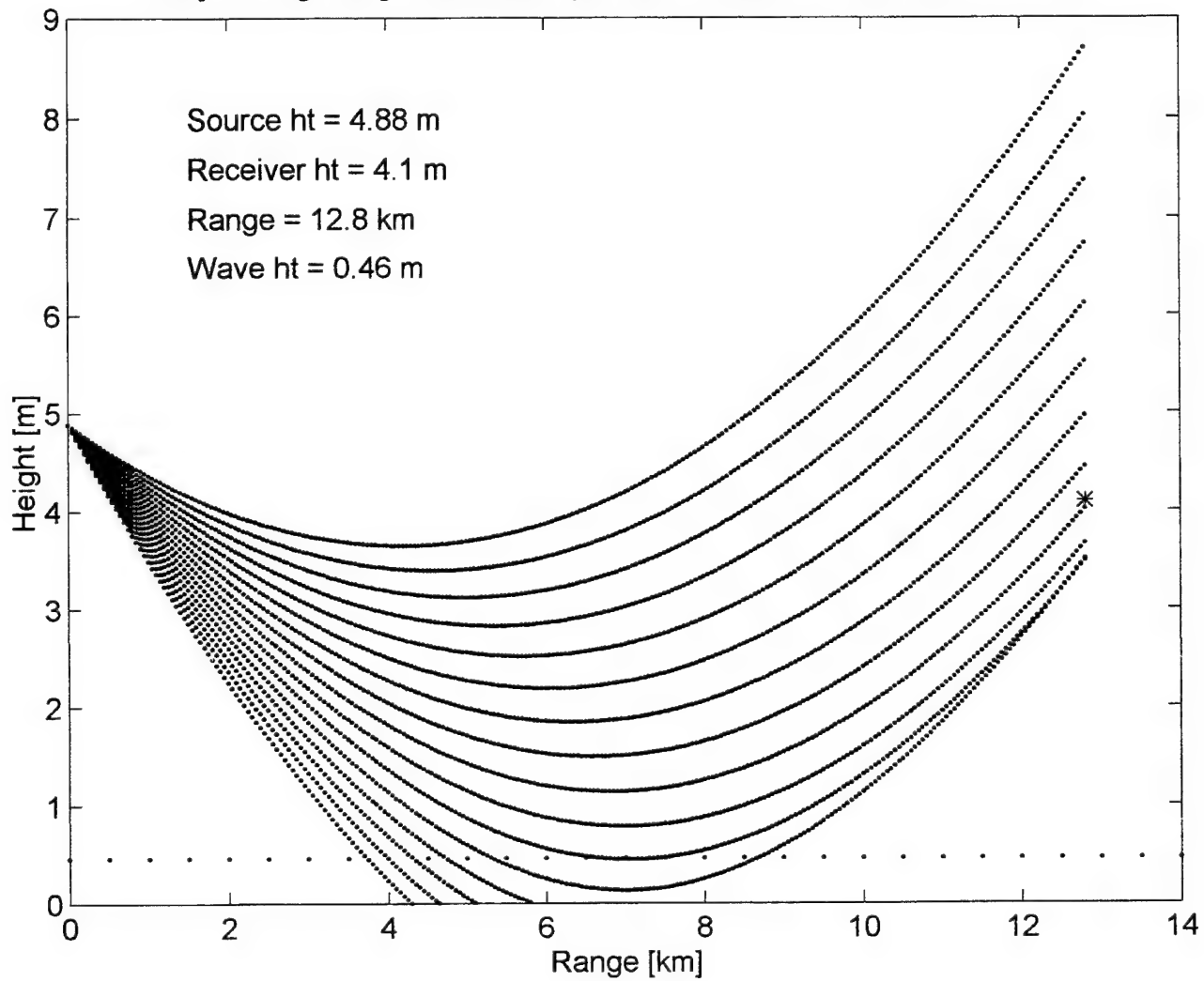
Ray tracing using modified temperature profile, 31 May 96, 951 hr



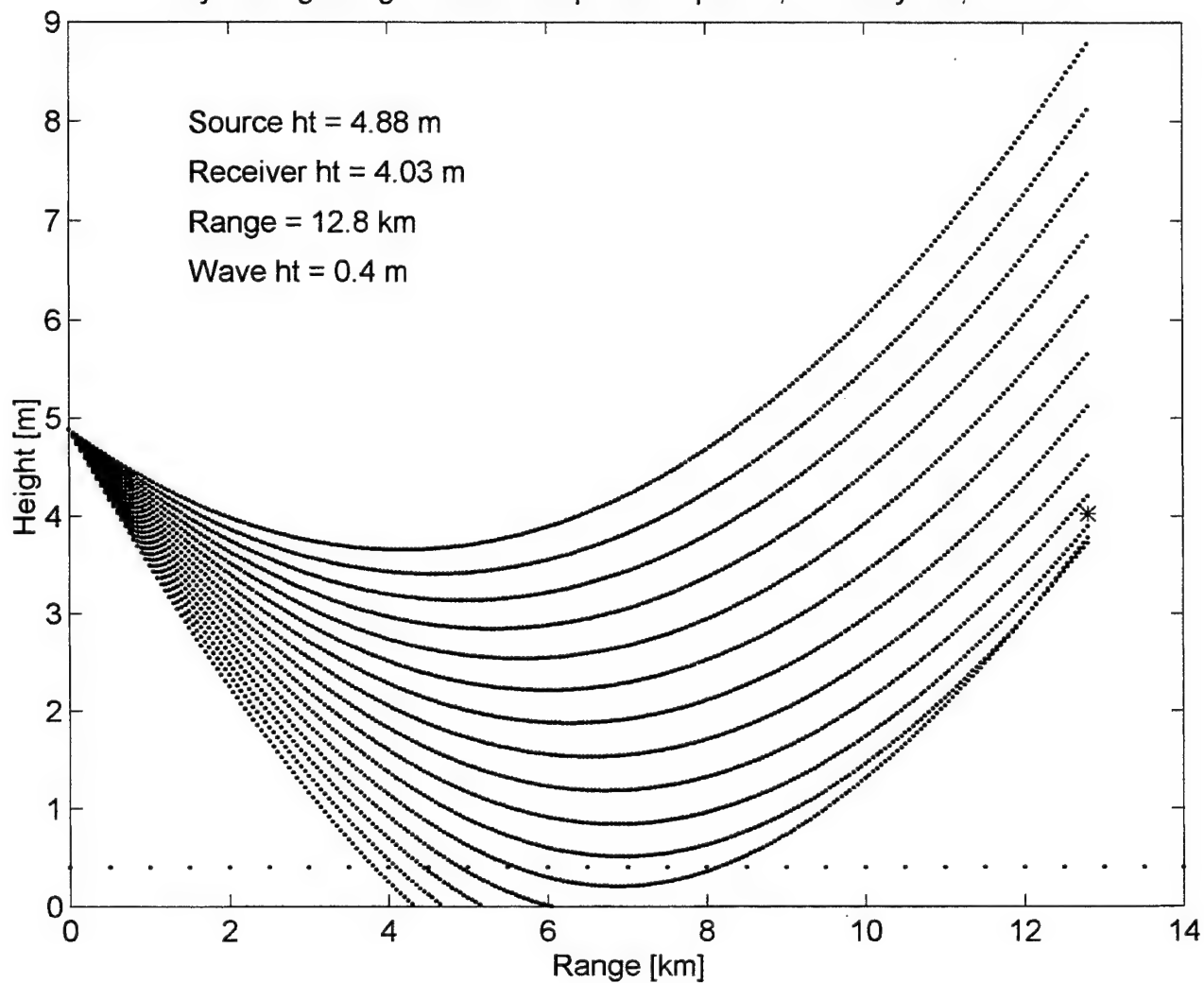
Ray tracing using modified temperature profile, 31 May 96, 1115 hr



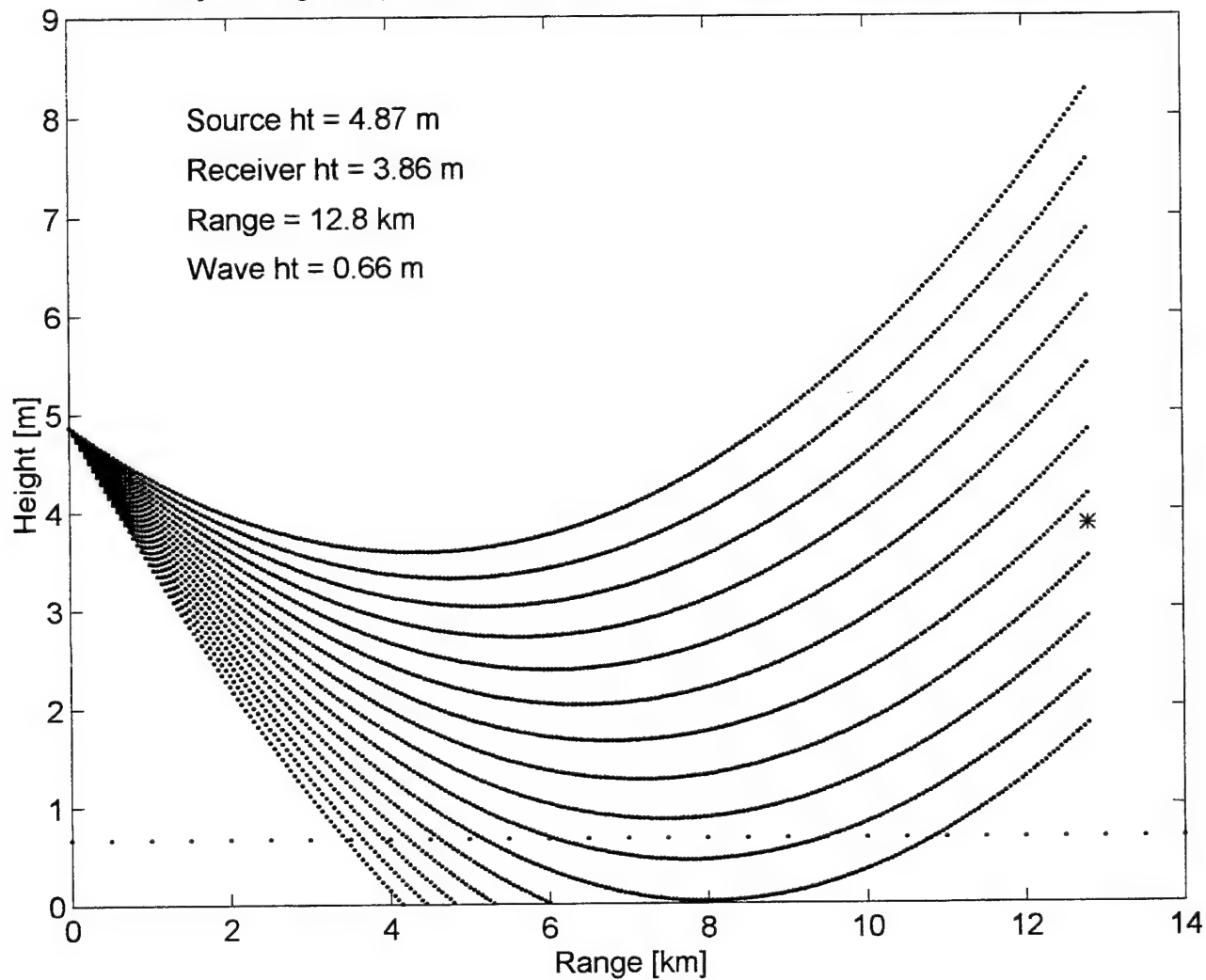
Ray tracing using modified temperature profile, 31 May 96, 1120 hr



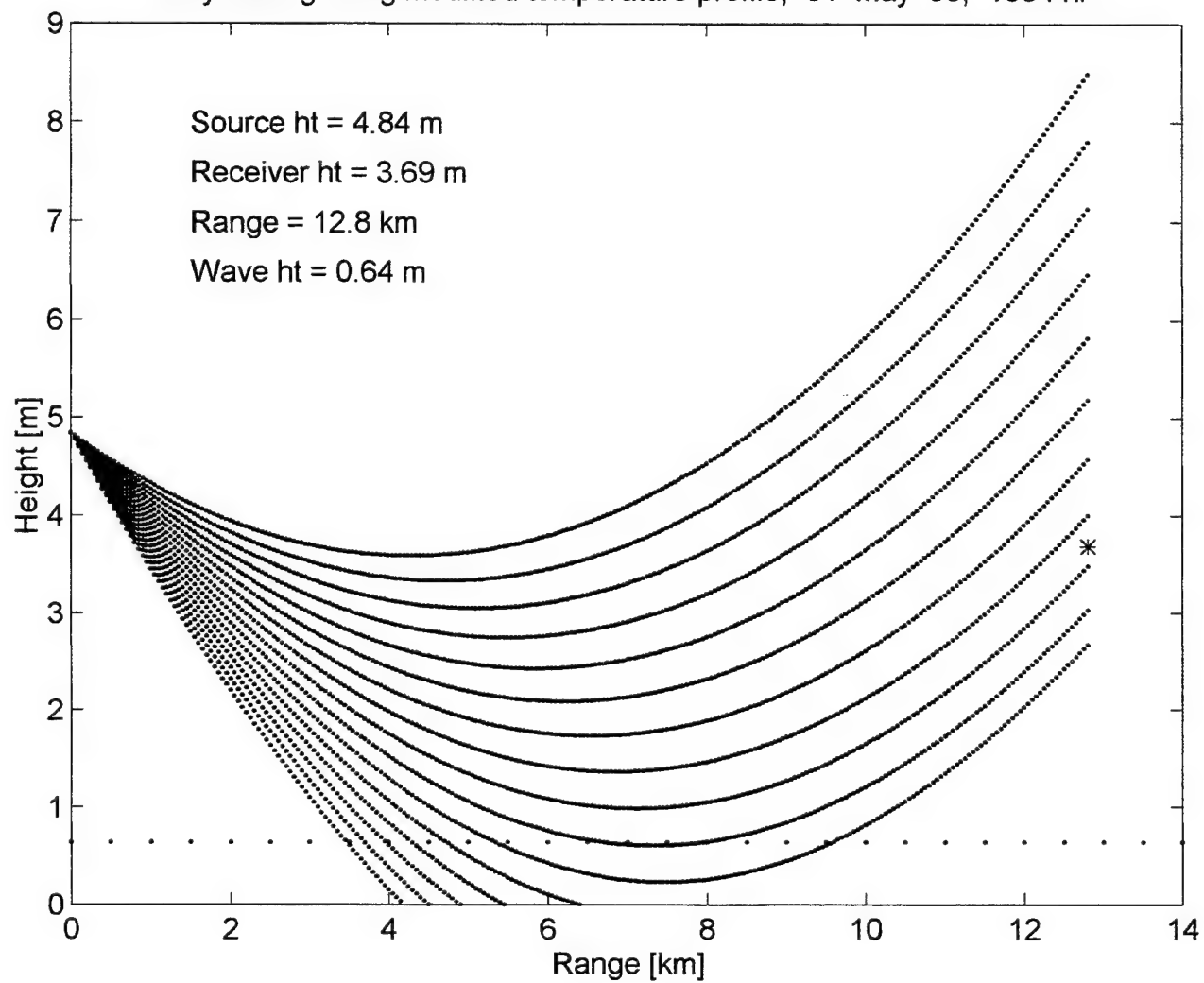
Ray tracing using modified temperature profile, 31 May 96, 1122 hr



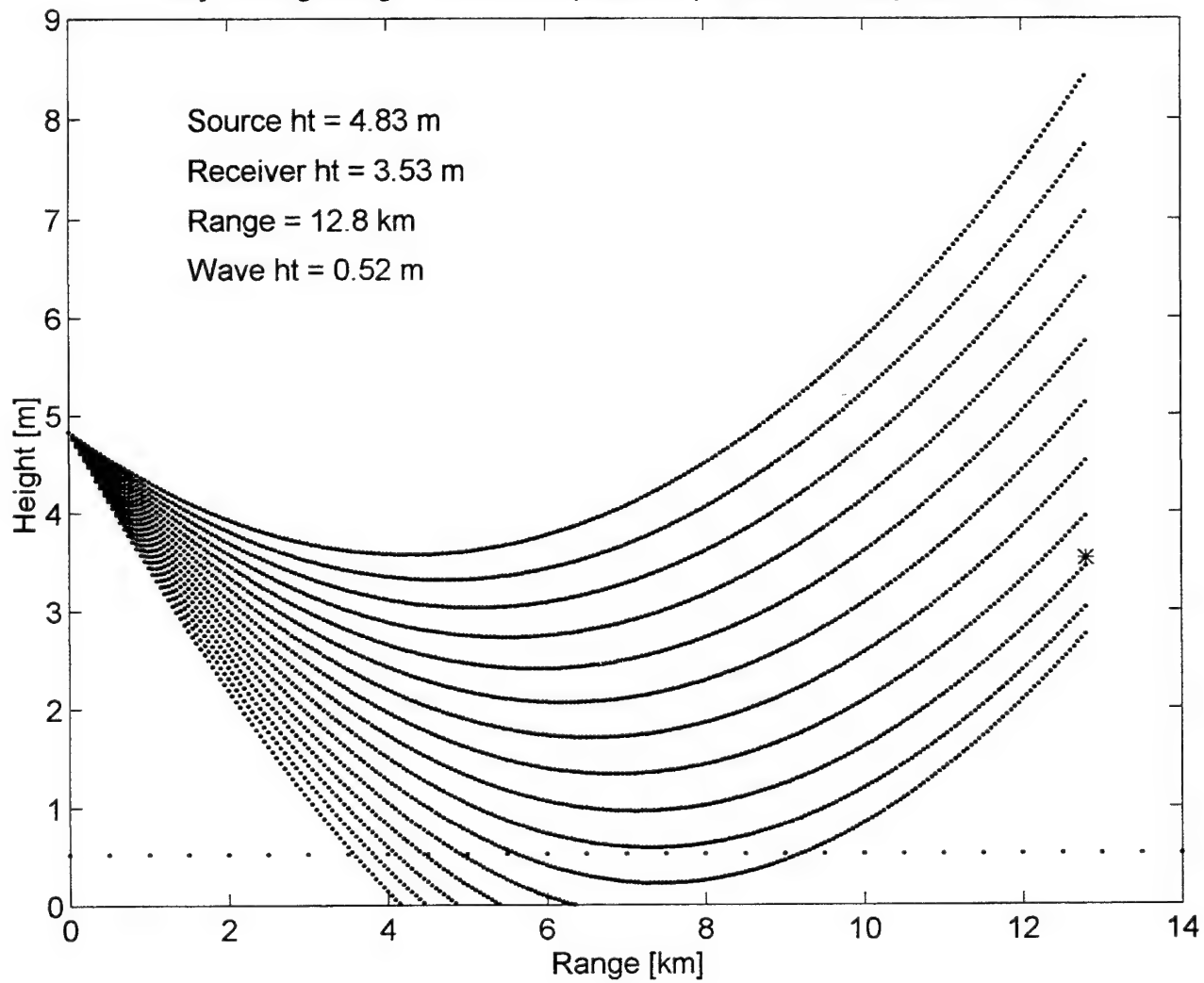
Ray tracing using modified temperature profile, 31 May 96, 1830 hr



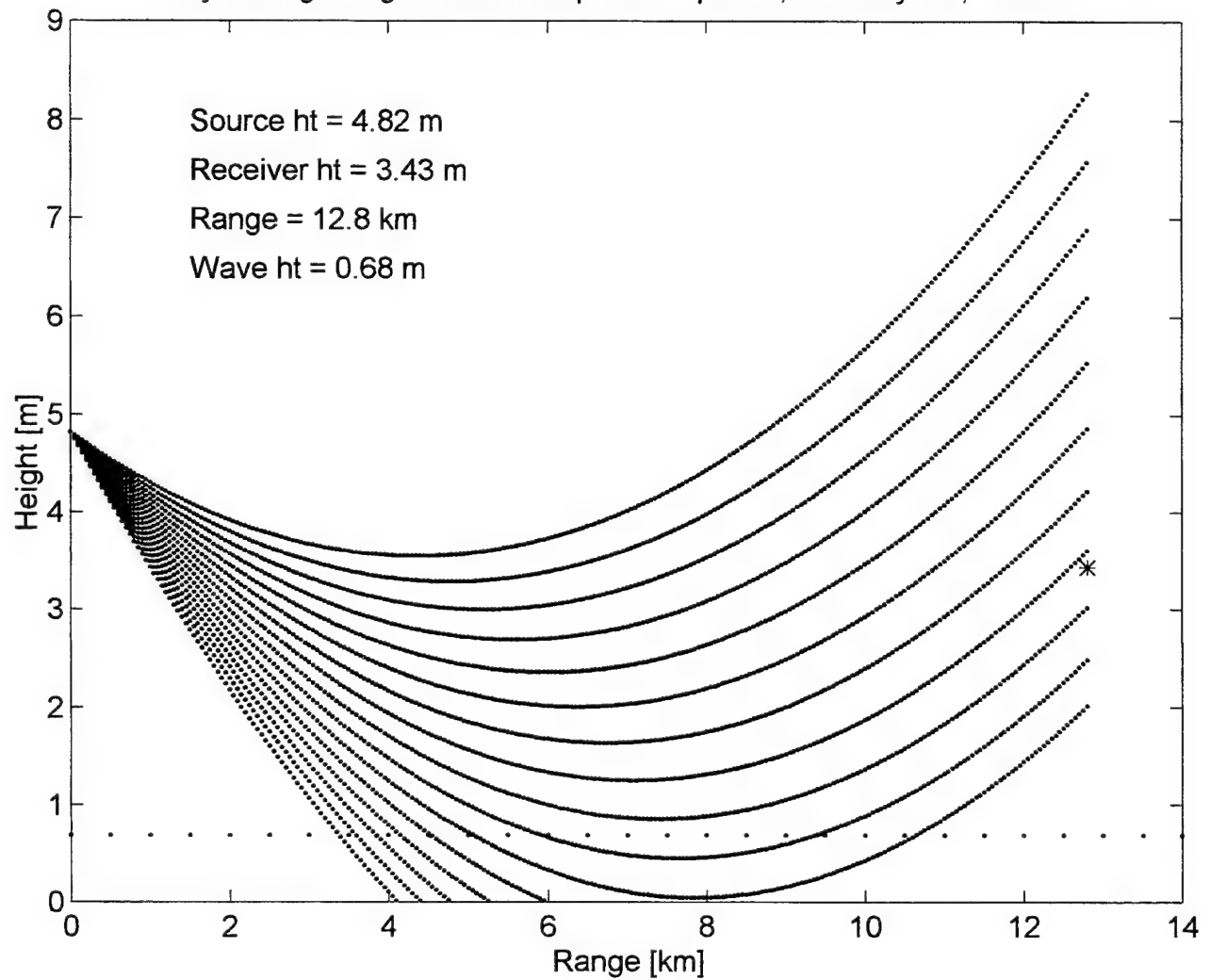
Ray tracing using modified temperature profile, 31 May 96, 1834 hr



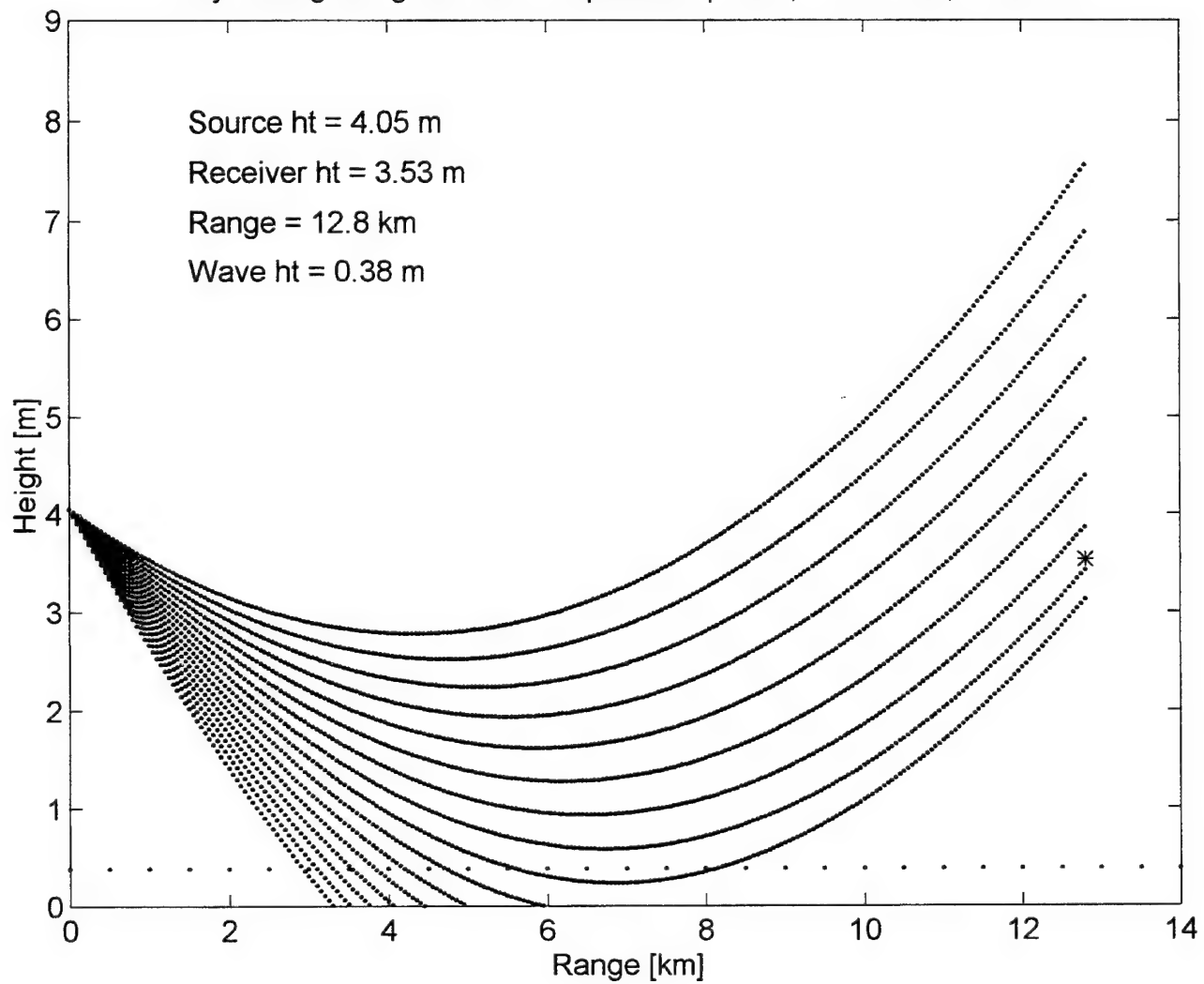
Ray tracing using modified temperature profile, 31 May 96, 1836 hr



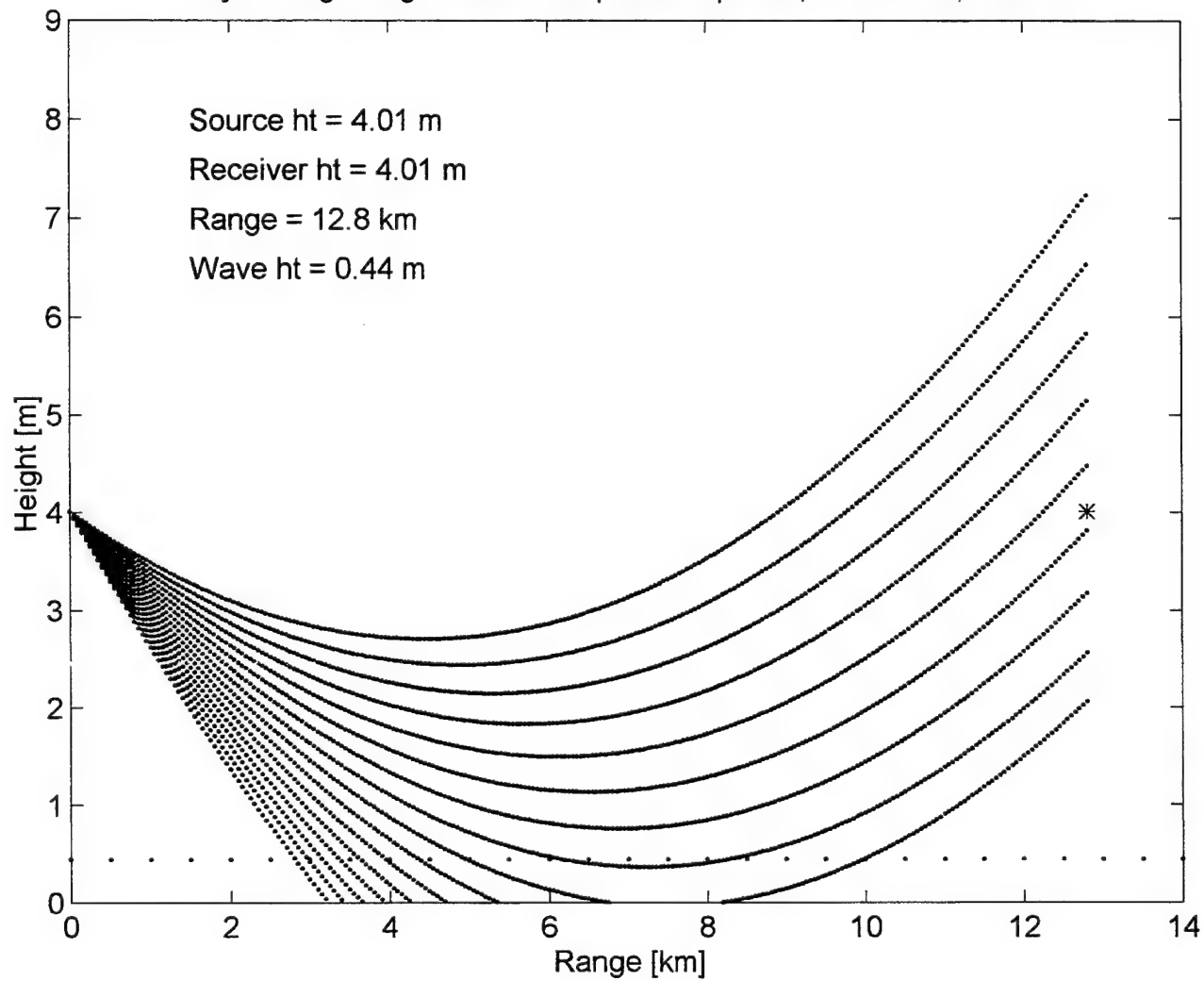
Ray tracing using modified temperature profile, 31 May 96, 1839 hr



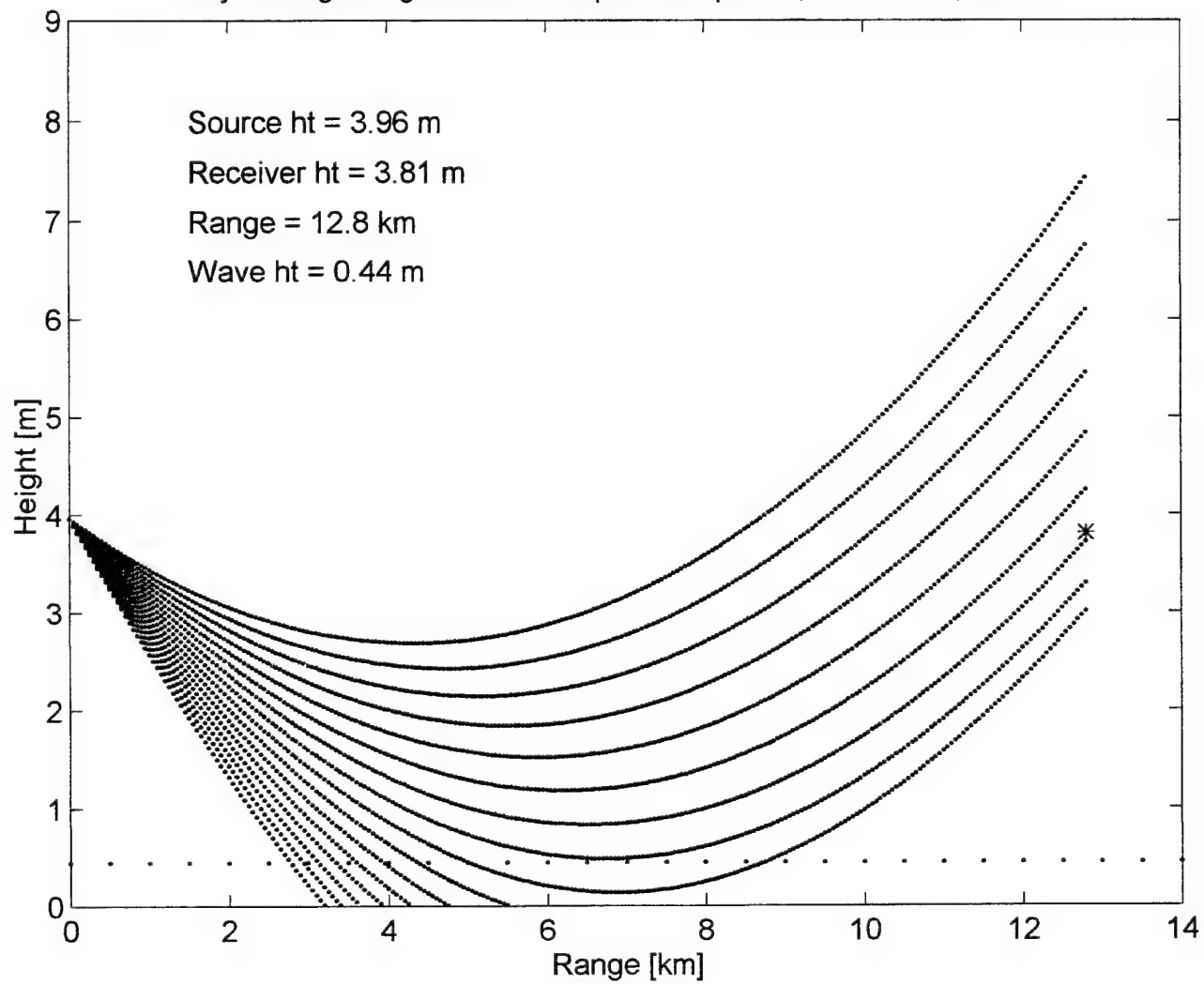
Ray tracing using modified temperature profile, 1 Jun 96, 2308 hr



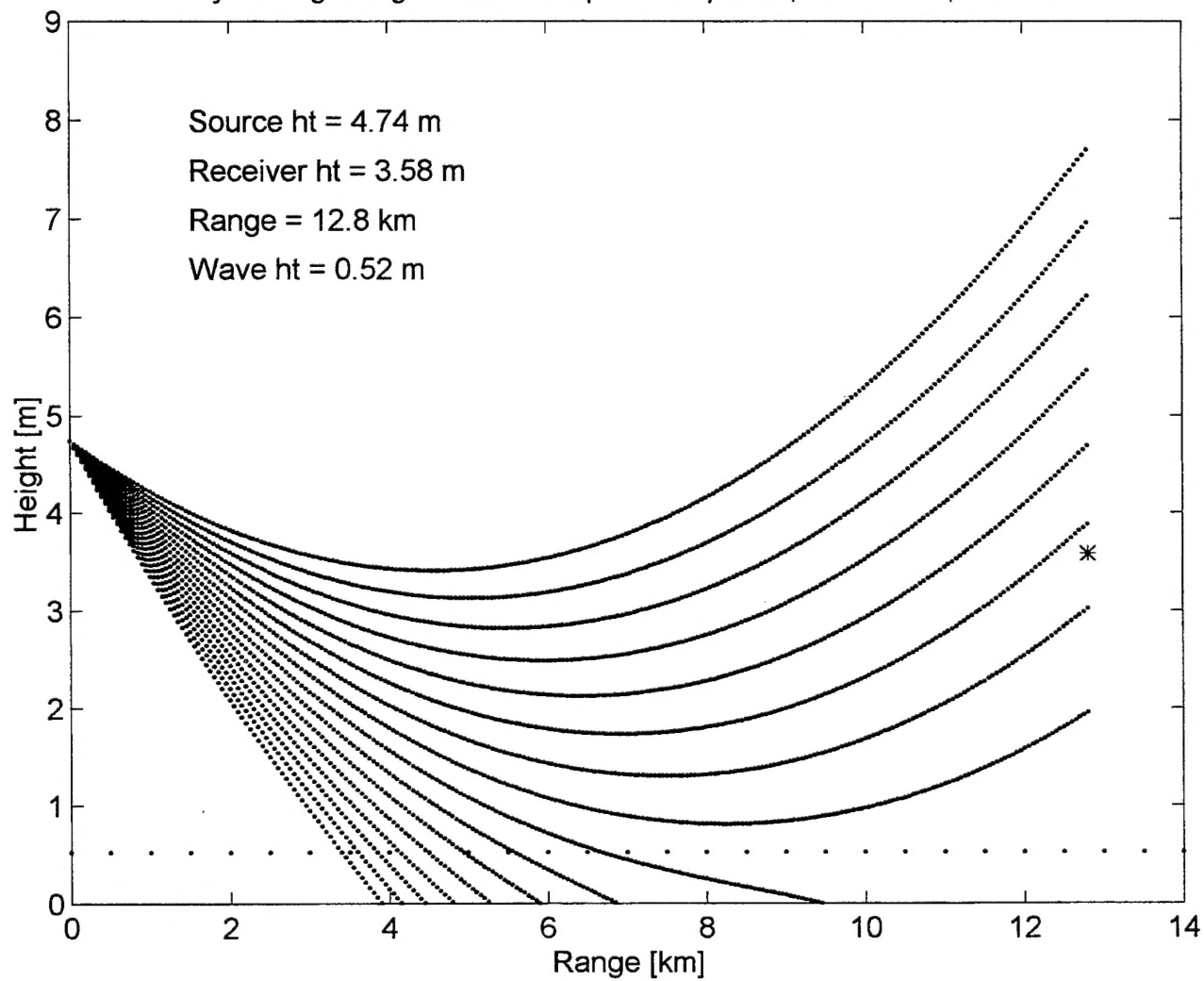
Ray tracing using modified temperature profile, 3 Jun 96, 930 hr



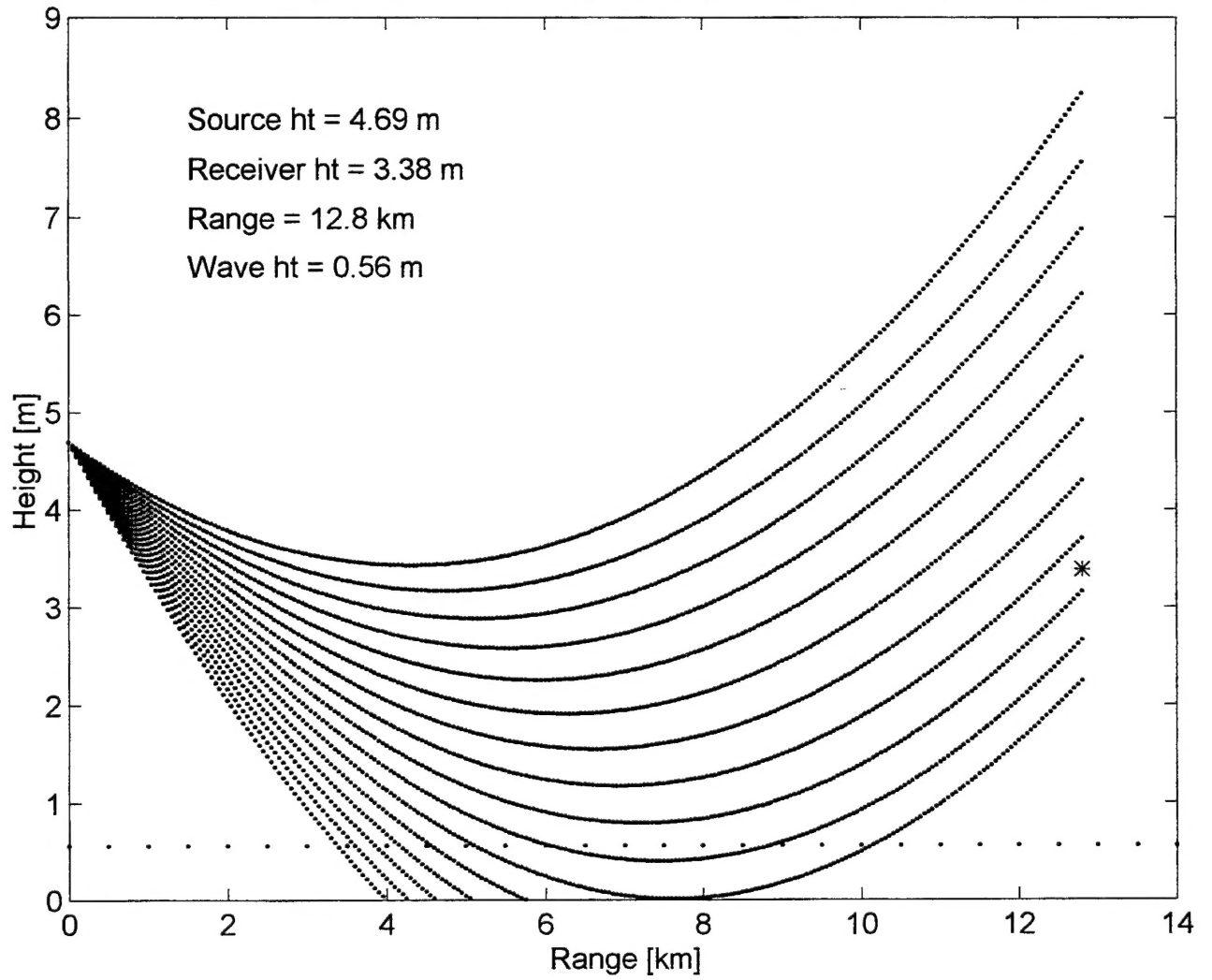
Ray tracing using modified temperature profile, 3 Jun 96, 937 hr



Ray tracing using modified temperature profile, 4 Jun 96, 1325 hr



Ray tracing using modified temperature profile, 4 Jun 96, 1426 hr



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| 9. | Lean-Weng Yeoh
59, Jalan Tari Serimpi
Singapore 799135
Republic of Singapore | 2 |
| 10. | Library, CSO
Ministry of Defence, Singapore
c/o 59, Jalan Tari Serimpi
Singapore 799135
Republic of Singapore | 2 |